LeCroy 9350, 9350M, & 9350L

Digital Storage Oscilloscopes

Basic Performance Test Procedure

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LeCroy

Innovators in Instrumentation

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SECTION 1 GENERAL INFORMATION

1.1 Initial Inspection

It is recommended that the shipment be thoroughly inspected immediately upon delivery to the purchaser. All material in the container should be checked against the enclosed Packing List. LeCroy cannot accept responsibility for shortages in comparison with the Packing List unless notified promptly. If the shipment is damaged in any way, please contact the Customer Service Department or local field office immediately.

1.2 Warranty

LeCroy warrants its oscilloscope products to operate within specifications under normal use for a period of two years from date of shipment. Spares, replacement parts and repairs are warranted for 90 days. The instrument's firmware is thoroughly tested and thought to be functional, but is supplied "as is" with no warranty of any kind covering detailed performance. Products not manufactured by LeCroy are covered solely by the warranty of the original equipment manufacturer.

In exercising this warranty, LeCroy will repair or, at its option, replace any product returned to the Customer Service Department or an authorized service facility within the warranty period, provided that the warrantor's examination discloses that the product is defective due to workmanship or materials and that the defect has not been caused by misuse, neglect, accident or abnormal conditions or operation.

LeCroy will return all in-warranty products with transportation prepaid.

This warranty is in lieu of all other warranties, expressed or implied, including but not limited to any implied warranty of merchantability, fitness, or adequacy for any particular purpose or use. LeCroy shall not be liable for any special, incidental, or consequential damages, whether in contract or otherwise.

1.3 Product Assistance

Answers to questions concerning installation, calibration, and use of LeCroy equipment are available from the Customer Service Department, 700 Chestnut Ridge Road, Chestnut Ridge, New York 10977-6499, U.S.A., tel: (914) 578-6060, or 6061, and 2 rue du Pré-de-la-Fontaine, 1217 Meyrin 1, Geneva, Switzerland, tel : (41) 22/719.21.11, or your local field engineering office.

1.4 Addresses

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1.5 Maintenance Agreements

LeCroy offers a selection of customer support services. Maintenance agreements provide extended warranty and allow the customer to budget maintenance costs after the initial two year warranty has expired. Other services such as installation, training, enhancements and on-site repair are available through specific Supplemental Support Agreements.

1.6 Documentation Discrepancies

LeCroy is committed to providing state-of-the-art instrumentation and is continually refining and improving the performance of its products. While physical modifications can be implemented quite rapidly, the corrected documentation frequently requires more time to produce. Consequently, this manual may not agree in every detail with the accompanying product. There may be small discrepancies in the values of components for the purposes of pulse shape, timing, offset, etc., and, occasionally, minor logic changes. Where any such inconsistencies exist, please be assured that the unit is correct and incorporates the most up-to-date circuitry. In a similar way the firmware may undergo revision when the instrument is serviced. Should this be the case, manual updates will be made available as necessary.

1.7 Service Procedure

Products requiring maintenance should be returned to the Customer Service Department or authorized service facility. LeCroy will repair or replace any product under warranty at no charge. The purchaser is only responsible for one way transportation charges.

For all LeCroy products in need of repair after the warranty period, the customer must provide a Purchase Order Number before repairs can be initiated. The customer will be billed for parts and labor for the repair, as well as for shipping.

1.8 Return Procedure

To determine your nearest authorized service facility, contact the Customer Service Department or your field office. All products returned for repair should be identified by the model and serial numbers and include a description of the defect or failure, name and phone number of the user, and, in the case of products returned to the factory, a Return Authorization Number (RAN). The RAN may be obtained by contacting the customer service department in New York, tel: (914)578-6060, or 6061 ; in Geneva, tel: (41)22/719.21.11, or your nearest sales office.

Return shipment should be made prepaid. LeCroy will not accept C.O.D. or Collect Return Shipments. Air-freight is generally recommended. Wherever possible, the original shipping carton should be used. If a substitute carton is used, it should be rigid and be packed such that the product is surrounded with a minimum of four inches of excelsior or similar shock-absorbing material. In addressing the shipment, it is important that the Return Authorization Number be displayed on the outside of the container to ensure its prompt routing to the proper department within LeCroy.

SECTION 2 SPECIFICATIONS

9350, 9350M, 9350L Digital Oscilloscope

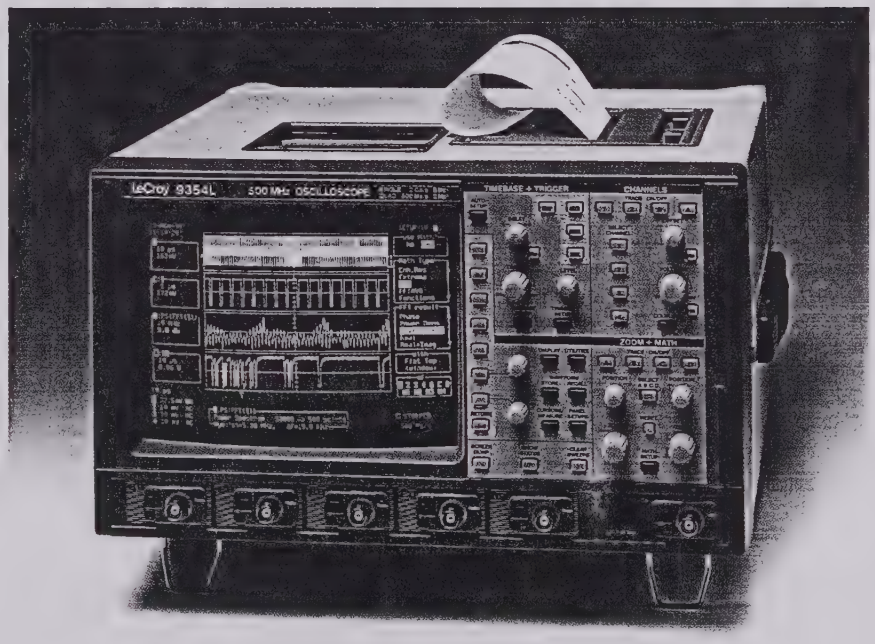
LeCroy

The Digital Scope Specialists

9350 Family Digital Oscilloscopes
500 MHz Bandwidth, 2 GS/s

Main Features

- Two and Four Channel versions
- Up to 8M Point record length
- 2.5 ns Peak Detect
- Glitch, Pattern, Qualified, Interval, Dropout and TV Triggers
- 8-bit vertical resolution, 11 with ERES option
- Fully programmable via GPIB and RS-232-C
- Automatic PASS/FAIL testing
- Advanced Signal Processing
- DOS Compatible Floppy Disk and Memory Card options
- Internal Printer Option



High speed and long memory make this family the ideal general-purpose Digital Storage Oscilloscopes. Two and Four Channel simultaneous sampling at 500 MS/s meets demanding high-speed design applications. Even faster sampling may be achieved by combining channels, up to a maximum of 2 GS/s.

Acquisition memories may also be combined, providing up to 8 M Points of continuous or segmented waveform recording. Repetitive signals are digitized at up to 10 GS/s. These combined capabilities make the 9350 family the state-of-the-art in current DSO technology.

A unique peak detect scheme captures 2.5 ns glitches - even at slow time bases - *without destroying the underlying data.* This provides circuit designers with the benefits of peak detection without any loss of precision.

Live waveforms may be viewed simultaneously with up to 3 expansions, showing all of the signal detail. Expansions are shown as highlights on the main trace.

SMART Trigger modes like Glitch, Pattern, Dropout and TV allow you to capture precisely the events of interest. Pre- and Post-Trigger delay, and Time and Events Holdoff are also standard.

The 9350 family features the proven user-interface of LeCroy's portable scopes. A bright, high-resolution 9" CRT allows optimum waveform viewing under any conditions. Menus and text are arranged around the graticules - they never overwrite the waveforms. Dedicated control knobs keep the scope's performance at your fingertips.

A comprehensive range of signal processing functions including FFT and Math on live or stored waveforms, allows extensive waveform manipulation. DOS compatible floppy disk and memory card options store waveforms and test setups, and simplify data transfer to any PC.

Features and Benefits

PRECISION ACQUISITION
The 9350 family combines all the technologies required for accurate waveform digitizing. Low-noise high-sensitivity amplifiers drive 500 MS/s 8-bit ADC's which are clocked simultaneously by a high-precision timebase. 500 MHz system bandwidth allows accurate risetime measurements below 1 nanosecond. Vertical resolution can be enhanced to 11 bits using ERES.

MEMORY FOR ALL APPLICATIONS
The 9350 family offers three different memory lengths:
25k points per channel (std. versions),
100k points per channel ("M" versions),
2M points per channel ("L" versions).
Memory length may be extended by combining the acquisition memories of multiple channels (see table below).

Long memories provide higher horizontal resolution. LeCroy's unique memory management system, combined with an advanced peak detection system, maximizes the benefits of longer memory. Showing the entire waveform onscreen allows immediate location of glitches or other disturbances, and guarantees the highest possible sample rate on all timebases.

THE MOST ADVANCED PEAK DETECT
9350 family members offer 2.5 ns peak detect, available whenever the digitizer system runs at below 200 MS/s. This captures fast glitches or signal details that might have been missed due to undersampling.

One unwanted effect of other peak detection systems is a severe loss of horizontal (time) precision. This occurs because detected peaks are known to have occurred *during* a particular interval, but not at any specific time. This means that signals acquired with other manufacturers' peak detection techniques cannot be successfully used for further processing or analysis.

LeCroy solves this problem by maintaining both peak detected *and* normally sampled waveforms for each signal. Thus the user gets all the benefits of peak detection without any loss of time precision.

EXTENSIVE TRIGGER SYSTEM
To capture rare or complex conditions, SMART trigger functions are available. These include Glitch with 2.5 ns resolution to trigger down to 1 ns and a unique Dropout mode, which triggers when the signal disappears for a selectable period of time. Other trigger modes include Pattern, Interval, State- or Edge-Qualified and TV.
TV trigger allows individual lines or fields in PAL, SECAM, NTSC and non-standard video to be selected. Pre- and Post-trigger delay are fully variable.

ProBus™ PROBE INTERFACE
The ProBus system provides a complete measurement solution from probe tip to oscilloscope display. ProBus is an intelligent interconnection between LeCroy oscilloscopes and a growing range of innovative probes, including high-bandwidth low-loading FET probes.

AUTOMATIC MEASUREMENTS
The following Parametric measurements are available, together with their Average, Highest, Lowest values and Standard Deviation:

amplitude	falltime	peak to peak
area	f 80-20%	period
base	f@level (abs)	risetime
cycles	f@level (%)	r 20-80%
delay	frequency	r@level (abs)
Δdelay	maximum	r@level (%)
Δt at level (abs)	mean	RMS
Δt at level (%)	median	std dev
Δt at level (t=0,abs)	minimum	top
Δt at level (t=0,%)	overshoot +	width
duty Cycle	overshoot -	

Pass/Fail testing allows up to 5 parameters to be tested against selectable thresholds. Waveform Limit Testing is performed using Masks which may be defined inside the instrument. Any failure will cause preprogrammed actions such as Hardcopy, Save, GPIB SRQ or Pulse Out.

DOS COMPATIBLE MASS STORAGE
All LeCroy 9300-series scopes offer an optional 3.5" 1.44 MB floppy disk drive which stores traces, setups, screen graphics and Pass/Fail templates. Data are stored as DOS files, which may be read directly by a PC. A high-speed DOS compatible PCMCIA memory card option is also available.

BUILT-IN PRINTER
As well as driving most printers and plotters via GPIB, RS-232-C and (optional) Centronics interface, the 9300 series offers an optional internal printer. This thermal printer produces full resolution screendumps, 126 x 90 mm, in under 10 seconds.

FLEXIBLE INTERFACING
GPIB and RS-232-C interfaces may be used for full remote control of the instrument. All front-panel and internal processing functions can be controlled via either interface. For applications where throughput is essential, the GPIB interface transfers hundreds of waveforms per second. A Front-Panel BNC connector may be setup to provide Pass/Fail test output pulses.

MULTIPLE DISPLAY MODES
The high-resolution raster display shows from one to four independent waveform grids. Waveforms are represented as dots joined by vectors which may be turned on or off. Four Zoom/Math traces may be used for zooming waveforms or for signal processing. The area to be zoomed is selected by moving an intensified portion of the main waveform. Persistence display mode allows easy viewing of signal changes over time, and XY mode plots any two sources against one another. Cursors are usable in all display modes.

EXTENSIVE WAVEFORM MATH
Standard built-in waveform processing includes mathematics (Add, Subtract, Multiply and Divide, Negation and Identity) and Summation Averaging (up to 1000 sweeps). Option WP01 provides Summed and Continuous Averaging, Waveform Math Functions, Extrema and Enhanced Resolution Modes. More information is available in the 9300 WP01 datasheet.

OPTIONAL FFT PACKAGE
Option WP02 provides comprehensive Spectral Analysis capabilities, permitting the system designer to identify characteristics which may not be apparent in the time domain. WP02 provides a wide selection of displayed projections and windowing functions, as well as averaging in the frequency domain. For more information, see the 9300 WP02 datasheet.

9350 Family Specifications

ACQUISITION SYSTEM
Bandwidth (-3 dB):
@ 50 Ω: DC to 500 MHz
Below 200 mV/div: 400 MHz
At 2 mV/div: 350 MHz
@ 1 MΩ DC: DC to 250 MHz typ. at probe tip.
No. of Channels: 4 (9354) or 2 (9350)
No. of Digitizers: 4 (9354) or 2 (9350)
Maximum Sample Rate and Acquisition Memories: See table below.
Sensitivity: 2 mV/div to 5 V/div, fully variable.
Scale factors: A vast choice of probe attenuation factors are selectable.
Offset Range: 2.0 - 9.9 mV/div: ± 120 mV
10.0 - 199 mV/div: ± 1.2 V
0.2 - 5.0 V/div: ± 24 V
DC Accuracy: ≤ ± 2% full scale (8 divisions) at 0 V offset.
Vertical Resolution: 8 bits.
Bandwidth Limiter: 30 MHz
Input Coupling: AC, DC, GND.
Input Impedance: 1 MΩ//15 pF or 50 Ω ± 1%.
Max Input:
1 MΩ: 250 V (DC+peak AC≤ 10 kHz)
50 Ω: ± 5 V DC (500 mW) or 5 V RMS

TIME BASE SYSTEM
Timebases: Main and up to 4 Zoom Traces.
Time/Div Range: 1 ns/div to 1000 s/div.
Clock Accuracy: ≤ 10 ppm
Interpolator resolution: 10 ps
Roll Mode: ranges 500 ms to 1,000 s/div. For > 50k points:10 s to 1,000 s/div.
External Clock: ≤ 100 MHz on EXT input with ECL, TTL or zero crossing levels.
External Reference: Optional 10 MHz rear-panel input.

TRIGGERING SYSTEM
Trigger Modes: Normal, Auto, Single, Stop.
Trigger Sources: CH1, CH2, Line, Ext, Ext/10 (9354: CH3, CH4). Slope, Level and Coupling for each can be set independently.
Slope: Positive, Negative.
Coupling: AC, DC, HF, LFREJ, HFREJ.
Pre-trigger recording: 0 to 100% of full scale (adjustable in 0.1 div increments).
Post-trigger delay: 0 to 10,000 divisions (adjustable in 1% div increments).
Holdoff by time: 10 ns to 20 s.
Holdoff by events: 0 to 99,999,999 events.
Trigger Bandwidth: Up to 500 MHz using HF coupling.
Internal Trigger Sensitivity Range: ± 5 div.
EXT Trigger Max Input:
1 MΩ//15 pF: 250 V (DC+peak AC≤ 10 kHz)
50 Ω ± 1%: ± 5 V DC (500 mW) or 5 V RMS
EXT Trigger Range: ±0.5 V (±5 V with Ext/10)
Trigger Timing: Trigger Date and Time are listed in the Memory Status Menu.

SMART TRIGGER TYPES
Pattern: Trigger on the logic AND of 5 inputs - CH1, CH2, CH3, CH4, and EXT Trigger, (9350: 3 inputs - CH1, CH2, EXT) where each source can be defined as High, Low or Don't Care. The Trigger can be defined as the beginning or end of the specified pattern.
Signal or Pattern Width: Trigger on width between two limits selectable from 2.5ns to 20s.
Signal or Pattern Interval: Trigger on interval between two limits selectable from 10ns to 20s
Dropout: Trigger if the input signal drops out for longer than a time-out from 25ns to 20s.
State/Edge Qualified: Trigger on any source only if a given state (or transition) has occurred on another source. The delay between these events can be defined as a number of events on the trigger channel or as a time interval.
TV: Allows selection of both line (up to 1500) and field number (up to 8) for PAL, SECAM, NTSC or non-standard video.

ACQUISITION MODES
Random Interleaved Sampling (RIS): for repetitive signals from 1 ns/div to 2 µs/div (M,L: from 1 ns/div to 5 µs/div).
Single shot: for transient and repetitive signals from 10 ns/div (all channels active).
Peak detect: captures and displays 2.5 ns glitches or other high-speed events.
Sequence: Stores multiple events in segmented acquisition memories.
Number of segments available:

9350-54	2-50
9350M-9354M	2-500
9350L-9354L	2-2,000

Dead Time between segments: ≤150 µs

DISPLAY
Waveform style: Vectors connect the individual sample points, which are highlighted as dots. Vectors may be switched off.
CRT: 12.5x17.5 cm (9" diagonal) raster.
Resolution: 810 x 696 points.
Modes: Normal, X-Y, Variable or Infinite Persistence.
Real-time Clock: Date, hours, minutes, seconds.
Graticules: Internally generated; separate intensity control for grids and waveforms.

Channels Used	Maximum Sample Rate	Memory per Channel 9350 9354	9350M 9354M	9350L 9354L	Notes
All Peak Detect OFF	500 MS/s	25k	100k	2M	All channels active
All Peak Detect ON	100 MS/s data 400 MS/s peak	10k data + 10k peaks	50k data + 50k peaks	1M data + 1M peaks	All channels active 2.5 ns peak detect
Paired Peak Detect OFF	1 GS/s	50k	250k	4M	9350: CH1 9354: CH2 + CH3
Paired + PP 092 Peak Detect OFF	2 GS/s	100k	500k	8M	9354 models only

Grids: 1, 2 or 4 grids.
Formats: YT, XY, and both together.
Vertical Zoom: Up to 5x Vertical Expansion (50x with averaging, up to 40 µV sensitivity).
Horizontal Zoom Factors:

9350-9354	500x
9350M-9354M	2,000x
9350L-9354L	40,000x

INTERNAL MEMORY

Waveform Memory: Up to four 16-bit Memories (M1,M2,M3,M4).
Processing Memory: Up to four 16-bit Waveform Processing Memories (A,B,C,D).
Setup Memory: Four non-volatile memories. Optional Cards or Disks may also be used for high-capacity waveform and setup storage.

CURSOR MEASUREMENTS

Relative Time: Two cursors provide time measurements with resolution of ±0.05% full-scale for unexpanded traces; up to 10% of the sampling interval for expanded traces. The corresponding frequency value is displayed.
Relative Voltage: Two horizontal bars measure voltage differences up to ±0.2% of full-scale in single-grid mode.
Absolute Time: A cross-hair marker measures time relative to the trigger and voltage with respect to ground.
Absolute Voltage: A reference bar measures voltage with respect to ground.

WAVEFORM PROCESSING

Up to four processing functions may be performed simultaneously. Functions available are: Add, Subtract, Multiply, Divide, Negate, Identity and Summation Averaging.
Average: Summed averaging of up to 1,000 waveforms in the basic instrument. Up to 10^6 averages are possible with Option WP01.
Envelope*: Max, Min, or Max and Min values of from 1 to 10^5 waveforms.
ERES*: Low-Pass digital filter provides up to 11 bits vertical resolution.
Sampled data is always available, even when a trace is turned off. Any of the above modes can be invoked without destroying the data.
FFT*: Spectral Analysis with four windowing functions and FFT averaging.
*Envelope and ERES modes are provided in Math Package WP01. FFT is in WP02.

AUTOSETUP

Pressing Autosetup sets timebase, trigger and sensitivity to display a wide range of repetitive signals. (Amplitude 2mV to 40V; frequency above 50Hz; Duty cycle greater than 0.1%).
Autosetup Time: Approximately 2 seconds.
Vertical Find: Automatically sets sensitivity and offset.

PROBES

Model: One PP002 (X10, 10 MΩ // 15 pF) probe supplied per channel.
The 9350 family is fully compatible with LeCroy's range of FET Probes, which may be purchased separately.
Probe calibration: Max 1 V into 1 MΩ, 500 mV into 50 Ω, frequency and amplitude programmable, pulse or square wave selectable, rise and fall time 1 ns typical. Alternatively, the Calibrator output can provide a trigger output or a PASS/FAIL test output.

INTERFACING

Remote Control: Of all front-panel controls, as well as all internal functions is possible by GPIB and RS-232-C.
RS-232-C Port: Asynchronous up to 19200 baud for computer/terminal control or printer/plotter connection.
GPIB Port: (IEEE-488.1) Configurable as talker/listener for computer control and fast data transfer. Command Language complies with requirements of IEEE-488.2.
Centronics Port: Optional hardcopy parallel interface.
Hardcopy: Screen dumps are activated by a front-panel button or via remote control. TIFF format is available for importing to Desktop Publishing programs. The following printers and plotters can be used to make hardcopies: HP DeskJet (color or BW), HP ThinkJet, QuietJet, LaserJet, PaintJet and EPSON printers. HP 7400 and 7500 series, or HPGL compatible plotters. An optional internal high resolution graphics printer is also available.

GENERAL

Auto-calibration ensures specified DC and timing accuracy.
Temperature: 5° to 40° C (41° to 104° F) rated 0° to 50° C (32° to 122° F) operating.
Humidity: < 80%.
Shock & Vibration: Meets MIL-STD-810C modified to LeCroy design specifications and MIL-T-28800C.
Power: 90-250 V AC, 45-66 Hz, 230 W.
Battery Backup: Front-panel settings maintained for two years.
Dimensions: (HWD)8.5"x14.5"x16.25", 210mm x 370mm x 410mm.
Weight: 13 kg (28.6 lbs) net, 18.5 kg (40.7 lbs) shipping.
Warranty: Two years.

Ordering Information

Oscilloscope and Options

9354/M/L	4-Ch Digital Oscilloscope
9350/M/L	2-Ch Digital Oscilloscope
935X-WP01	Waveform Math
935X-WP02	FFT Processing
935X-MC01	Memory Card Reader
935X-FD	Internal 3.5" Floppy Drive
935X-GP	Internal Graphics Printer
935X-XR	10 MHz Reference Input

Oscilloscope Accessories
Supplied with Instrument:

935X-OM	Operator's Manual
93XX-RCM	Remote Control Manual
93XX-FC	Front Cover
PP002	10:1 Oscilloscope Probe (1 per channel)
PP092	ProBus Channel Multiplexer (9354 only)

Ordered separately:

93XX-W5	5 years extended warranty
93XX-CC	Calibration Certificate
935X-SM	Service Manual
935X-MC02	128K Memory Card
935X-MC04	512K Memory Card
DC/GPIB-2	2 Meter GPIB Cable
SG9001	High Voltage Protector
OC9001	Oscilloscope Cart
AP020	1 GHz 10:1 FET Probe
AP021	800 MHz 5:1 FET Probe
AP030	25 MHz Differential Probe
PP090	ProBus 75 to 50 Ω adapter
93XX-RM01	Rackmount
93XX-TC1	Transit Case
93XX-TC2	Carrying Bag

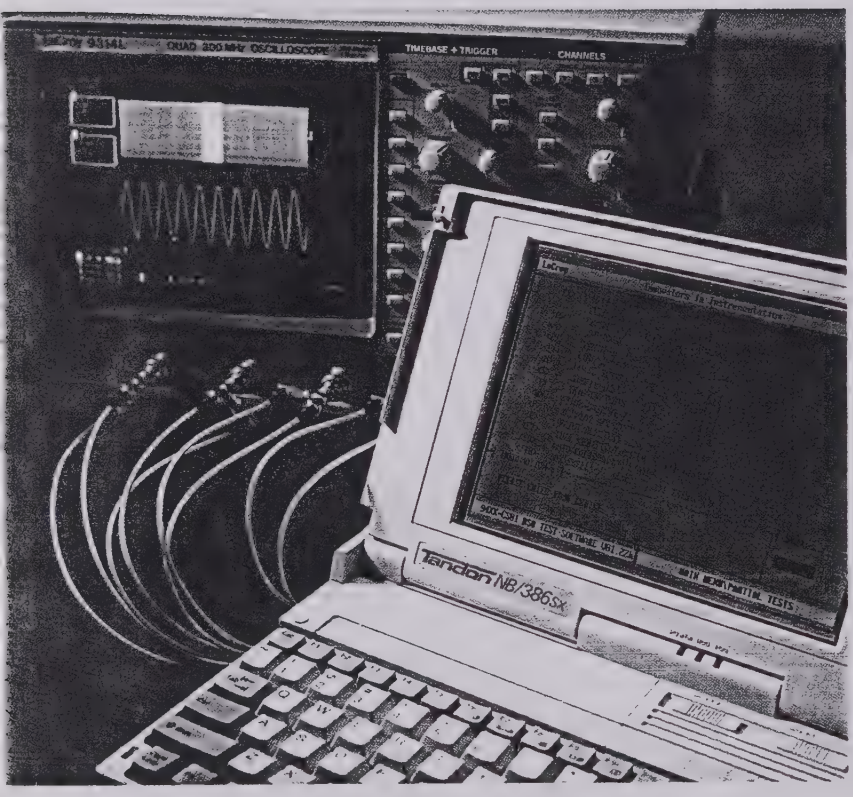
USA Direct Sales: 1 (800) 5LE-CROY

LeCroy Worldwide Sales Offices

ASIA/PACIFIC	LeCroy Pty Ltd	61.38.90.7358
BENELUX	LeCroy BV	04902.8.9285
FRANCE	LeCroy SARL	(1).69.18.83.20
GERMANY	LeCroy GmbH	06221 83.10.01
ITALY	LeCroy SRL	06.336.797.00
JAPAN Osaka	LeCroy Japan	0816.330.0961
JAPAN Tokyo	LeCroy Japan	0813.3376.9400
SWITZERLAND	Geneva	022.719.21.11
SWITZERLAND	Lenzburg	064.51.91.81
United Kingdom	LeCroy Ltd	(0235) 533114

LeCroy
Innovators in Instrumentation

LeCalsoft–Calibration Software for LeCroy Digital Oscilloscopes



The LeCalsoft package enables a fast and thorough verification of all key specifications.

Main Features

- Traceability to reference standards
- Computer check of key specifications
- Computer–aided readjustment
- Fully automated configurations available
- Supports all 93XX and 94XX models
- IBM® PC–AT compatible

General

The LeCroy LeCalsoft (94XXCS05) test and calibration package provides a convenient, unambiguous check of LeCroy oscilloscopes. Designed for users who require traceability to reference standards (NIST, etc.), this package is ideally suited for use in calibration laboratories where the oscilloscopes are checked at fixed intervals.

Results of the calibration check are fully documented on hard copy, or they can be archived on hard disk or diskette.

LeCalsoft works on any PC compatible with the IBM®–AT standard. It controls the oscilloscope and the calibration sources through a National Instruments® GPIB interface.

Features

Calibration Check

All the essential specifications of the Digital Oscilloscope, such as bandwidth, linearity, noise, trigger, timebase and effective–bit count are tested. Deviations from nominal values are calculated and displayed on the screen, printed, or archived on hard disk or diskette.

Comprehensive Documentation of the Test Results

At the end of each calibration check, two types of documentation are available: a long form printout which gives details of the results of all the tests executed, and states whether or not the results are within the specifications, and a short form printout which gives a summary of the test results.

Calibration Traceable to National Standards (NIST, etc.)

By using signal sources traceable to a standard, the calibration will be traceable to the same standard, provided the relevant documentation is maintained.

Manual and Automated Calibration Check

Both manual operation with computer assistance, and automated operation are possible. Automated operation requires programmable multiplexer and signal sources. See the list of supported devices below.

Assisted Adjustment of the Oscilloscope

A computer–aided adjustment procedure is also provided. By following instructions on the screen, the trained technician is guided through the adjustments required to correct the settings of the oscilloscope so that it is within the specifications.

Calibration Certificate

On request, LeCroy will perform calibration traceable to National Standard Organizations. Calibration certificates are provided as part of this service.

Functional Description

Calibration Practice

LeCroy oscilloscopes are auto–calibrating digital oscilloscopes and therefore do not require regular calibration like analog oscilloscopes. However, for users who require traceability to reference standards (such as those provided by the National Institutes of Standards and Technology), and for calibration laboratories which must inspect incoming instruments and perform recalibration at prescribed intervals, the LeCalsoft computer–aided test and calibration packages provide an easy solution.

Under guidance of the LeCalsoft program, some adjustments to the oscilloscope can be made by an electronics technician. However major deviations from specifications usually require repair by a trained service engineer. LeCroy regularly schedules training classes. If no in–house trained person is available, the nearest LeCroy service center can carry out repairs and calibration, and provide traceability to reference standards.

Using the LeCroy LeCalsoft Packages

For calibration checking, digital oscilloscopes have a great advantage over analog oscilloscopes because waveforms can be transferred to a host computer. This simplifies the calibration procedure enormously, makes it potentially faster and allows an extensive range of tests with unambiguous interpretation of the results.

LeCalsoft performs an extensive series of tests which verify the specifications of the oscilloscope. It includes many tests relevant to analog scopes such as Noise and Linearity tests. Although these tests are difficult and time consuming on an analog oscilloscope, they can be computer controlled and are quickly and easily performed on a digital oscilloscope. Tests which are specific to digital oscilloscopes, such as Sinefit tests are also included.

The various test options in LeCalsoft are presented to the operator in the form of a simple menu system. The user has the choice of performing an automated calibration check of the oscilloscope, or individually testing any of the specifications. Some of the tests require the use of high–quality external signal generators. The user receives instructions on the screen when it is necessary to change the cable connections, but apart from this minor intervention, the tests are fully computer controlled when supported GPIB–programmable instruments are used.

Supported Instrumentation

LeCalsoft software works on any AT–compatible equipped with a math coprocessor and a National Instruments GPIB interface. Automated calibration checking is possible using a set of instruments from the following list. (For an automated calibration check, either the LeCroy or Keithley programmable multiplexer is required to feed the calibration signals to the oscilloscope input.)

RF sinewave generators:
- Marconi 2019A, 2022C, 2030, 2031
- Fluke 6060B, 6061A
- Hewlett–Packard 8642A, 8642B
- Rohde & Schwarz SMX

AF sinewave generators:
- Marconi 2019A, 2022C, 2030, 2031
- Hewlett–Packard 8642A, 8642B
- Rohde & Schwarz SMX
- Tektronix FG5010
- LeCroy AFG 9100

DC Precision Power Supply:
- Tektronix PS5004
- Datron 4708 Autocal Multifunction Standard

Fast Pulse Generator:
- Tektronix CG5001/CG551AP

Power Meters:
- Hewlett–Packard HP436A, HP437B

Multiplexers:
- Keithley 199 SYSTEM DMM/ SCANNER with LeCroy interface board.
- LeCroy 4951, 4973–1, 4973–2 Multiplexers.

Frequency standard:
- WWV or HBG1500

Recommended Accessories

A full kit of calibration connectors and interfaces is available from LeCroy. It includes all the necessary cables, adapters, splitters and filters, as well as the Programmable Multiplexer. Also available is a repair package including special tools, board extenders, etc., for computer–aided adjustment.

Use of Other Instruments

It is possible to perform the calibration check with some other unsupported signal sources. However, the user is then required to set up these instruments manually and to perform one measurement at a time. The LeCalsoft package guides the user step by step, and controls the oscilloscope data acquisition and the computation of the results.

LeCalsoft compares the signal measured by the oscilloscope with the signal it would expect to receive from the generator. Warning messages are displayed whenever tolerances are exceeded. Some of the adjustments may be carried out by the user when the test sequence is finished. In this case, the software will guide the user through the correct adjustment procedure. At the end of the calibration check, a printout can be generated to list the results.

Specifications

Computer Required: Any PC compatible with the IBM–AT standard, and equipped with a mathematical coprocessor and a National Instrument Inc. GPIB interface.

Operating System: DOS 3.0 upward

Medium: $3^1/_2$" 1.44 Mb
$5^1/_4$" 1.2 Mb diskette

Major Tests Supported by LeCalsoft

Internal

To ensure proper calibration of the oscilloscope, internal auto–calibration tests are automatically executed during normal operation. This standard sequence of internal auto calibration tests is initiated by the software and the results are transferred to the PC for analysis.

The tests are:

- Calibration of the resolution of the time–to–digital converter with respect to the system clock
- Determination of the gain constants of the input amplifiers
- Offset compensation versus gain variation
- Global internal non–linearity
- General functionality check

Bandwidth

To calculate the bandwidth, the amplitudes of sine waves of increasing frequencies are measured. The sine wave generator is first set to 500 kHz with an amplitude 75% of full screen, i.e. ±3 vertical divisions. The frequency is then swept up to the point where an amplitude drop of 3 dB is observed. This indicates the bandwidth.

This test is executed on all channels for 1 MΩ and 50 Ω input impedance and for all vertical sensitivities. It requires a sine wave generator with good flatness.

Generators supported under program control are listed on page 2.

Linearity

15 different known voltages, varying from 5% to 95% of full screen, are applied by the external voltage reference source. For each voltage value, a full waveform is acquired, and the mean value is compared to the known input voltage. The linearity is determined through a linear regression fit to the 15 measurements.The slope, the offset and the chi–square of the fit are computed.

With the linearity test, many other related tests are performed: response time of the overload protection of the 50 Ω input, linearity of the variable gain calibration, range and linearity of the offset setting, and quality of the input coupling.

This procedure is executed on all channels for both 1 MΩ and 50 Ω input impedance. The test requires a DC source with a precision and time stability of 0.1%, a voltage range of 0 V to 20 V adjustable in steps of 5 mV, and an output current capability of 300 mA.

Power supplies supported under program control are listed on page 2.

Noise

The noise tests are executed on all channels for both 1MΩ and 50 Ω input impedance, with AC and DC coupling, five different time–base settings, and open inputs. Full waveforms are acquired with different offset values. The peak–to–peak as well as the RMS values of each measurement are computed, and the maximum values are recorded. The program also indicates the occurrence of any "flyers", i.e. short noise peaks generated by the ADC's.

The noise tests also include:

- checking the linearity of the variable offsets of all channels between 2.5% and 97.5% of full screen.
- checking the stability of the ground line when switching the inputs between GROUND and DC coupling modes.

Rise time/Overshoot

Executed on all channels for both 1MΩ and 50 Ω input impedance, these tests measure the rise time of the oscilloscope response to the input voltage step, as well as the amount of pre–shoot and overshoot. They require a voltage step generator with calibrated fast rise–time amplitude.

The Voltage Step Generator supported under program control is the Tektronix CG5001.

Sinefit

The performance of the analog–to–digital converter is evaluated in terms of the number of effective bits (a measure of the signal–to–noise ratio). It is measured on all channels, at a sensitivity of 50 mV/div., by applying a pure sine wave at varying frequencies and timebase settings

This test is a measurement of dynamic linearity. It shows the effect of such errors as noise, non–linearities and aperture jitter.

Timebase

The timebase test compares the internal clock with a very precise and stable external timebase reference (clock generator) such as the WWV standard or HBG 1500.

Trigger

The trigger capabilities are tested for all possible configurations. These include:

- Internal and external trigger sources
- DC, AC, HF–reject, and LF–reject couplings
- Trigger level settings in all slope modes.

SECTION 3 Performance Verification

3.1 Introduction

This procedure can be used to verify the main operating specifications of the LeCroy 9350/M/L digital storage oscilloscope, it is useful as a calibration verification procedure, as well as an incoming inspection checkout. It is time consuming and requires extensive test equipment. If you are not familiar with operating the 9350/M/L oscilloscope, read the operator's manual.

3.2 Test Equipment Required

Instrument	Qty	Specifications	Recommended	Where used
Signal Generator (sine wave)	1	Frequency : .5 MHz to 1 GHz Frequency Accuracy : 1 ppm Amplitude : 1 V peak to peak	Marconi 2030 or equivalent	3.9.1.a 3.11 3.12
Leveled Sine wave generator	1	Frequency : .5 MHz -250 MHz Amplitude : 5 V peak to peak	Tektronix SG503 or equivalent	3.9.1.b
Fast pulse Generator	1	Rise time < 500 psec	LeCroy 4969 or equivalent	3.13
Sine Wave Generator	1	Frequency : 5 KHz Amplitude : 6 V peak to peak	any Generator	3.10
DC precision Power Supply	1	Amplitude : 10 V, DC Accuracy : < 0.1 %	Tektronix PS5004	3.7, 3.8 3.15
Digital Multimeter	1	4 digits	Keithley 199 or equivalent	3.4 3.5
Cable	1	BNC, 50 Ω, length 20 cm, 1ns (7.87 inches)	LeCroy 4802432001	3.10.3 3.10.4
Cable	1	BNC, 50 Ω, length 100 cm, 5 ns (39.37 inches)	LeCroy 480020101	3.XX
Attenuator	1	50 Ω, 20 dB 1% accuracy	Suhner	3.7
Attenuator	1	1 MΩ, 20 dB 1% accuracy	Suhner	3.7
Attenuator	1	50 Ω, 3 dB 1% accuracy	Suhner	3.10
Terminator	1	50 Ω Feed through	Suhner	3.13
BNC T adapter	1	BNC, 50 Ω, T adapter	LeCroy 402222002	3.10.3 3.10.4

Table 3-1 : Test Equipment

3.3 Turn On

- Switch on the power using the power switch on the rear panel and verify :
- The display turns on after about 10 seconds and is stable
- The range of intensity and grid intensity is reasonable
- Wait for about 10 minutes for the scope to reach a stable operating temperature.

3.4 Input Impedance

Specifications

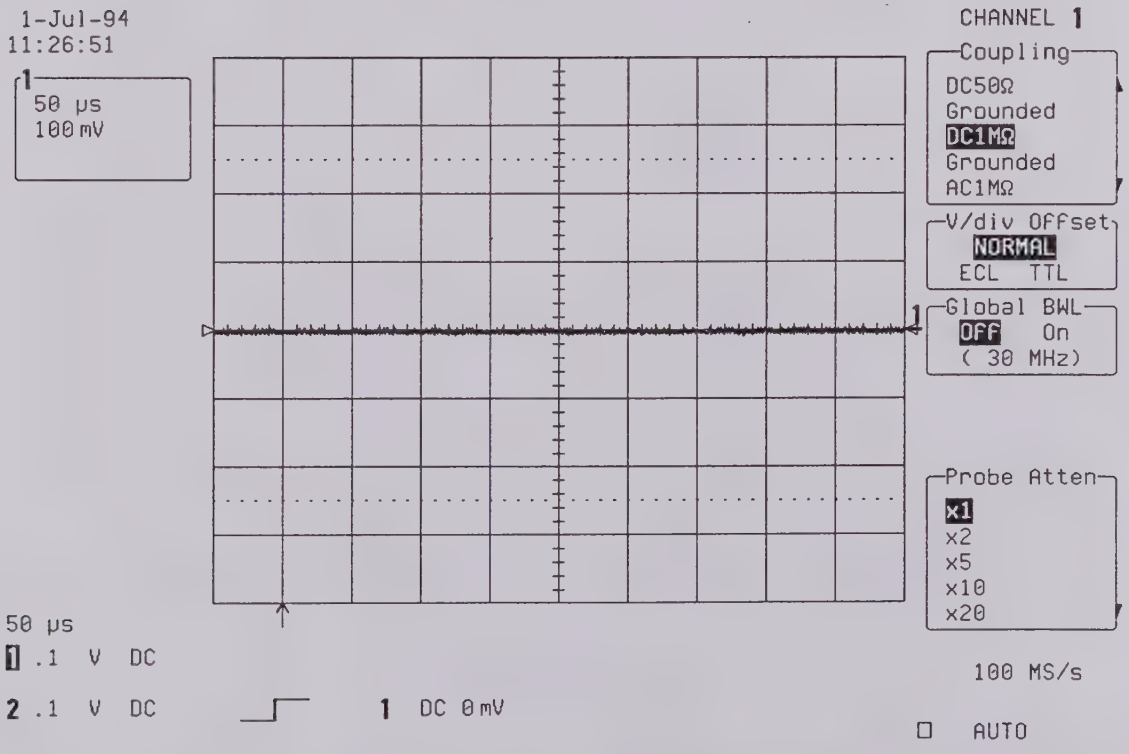
DC 1MΩ ± 1%
DC 50 Ω ± 1%

3.4.1 Procedure

The input impedance is tested in working conditions, with a high precision digital multimeter.

3.4.1.a DC 1MΩ

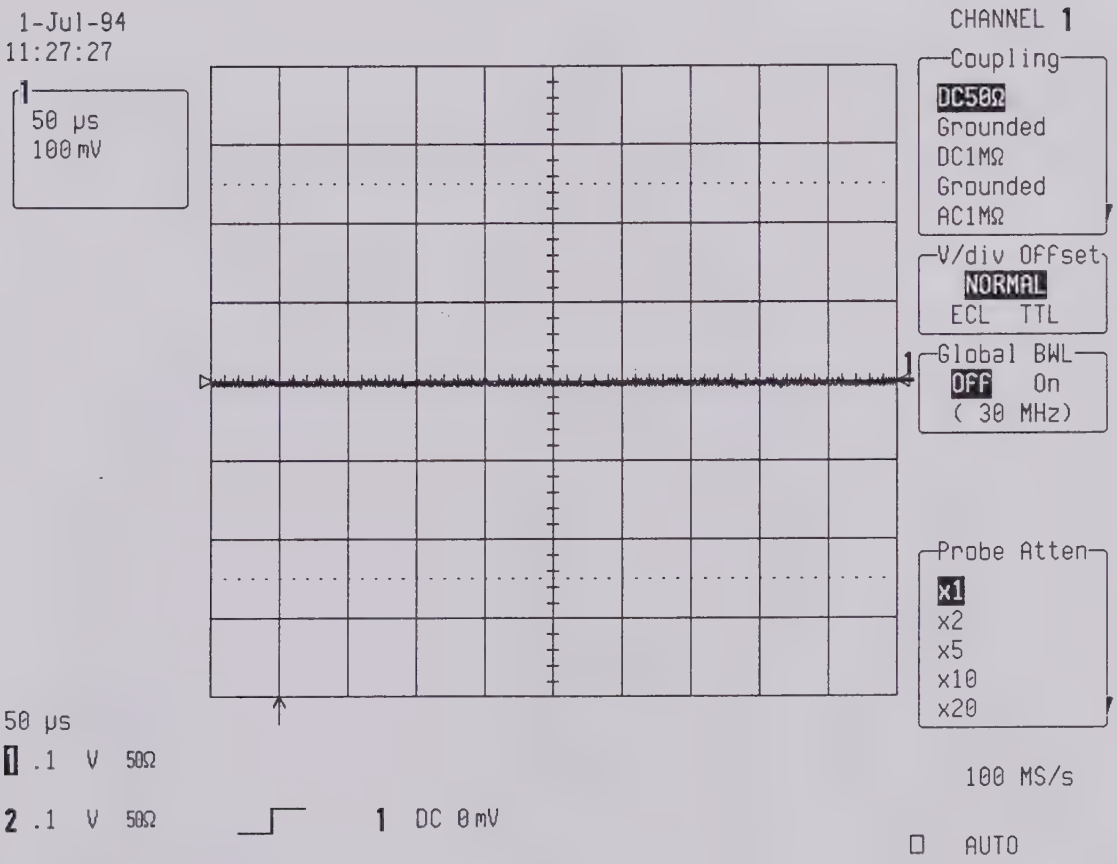
- Set DSO Channel 1 : **On**
- Input Coupling : **DC 1MΩ**
- Input gain : **100 mV/div.**
- Trigger on : **Channel 1**
- Trigger mode : **Auto**
- Time base : **50 µsec/div.**



- Measure the impedance using a high precision DMM with sense : must be **1MΩ ±1%**.
- Repeat the above test for input volt/div. of **200 mV**.

3.4.1.b DC 50Ω

- Set DSO Channel 1 : **On**
- Input Coupling : **DC 50Ω**
- Input gain : **100 mV/div.**
- Trigger on : **Channel 1**
- Trigger mode : **Auto**
- Time base : **50 µsec/div.**



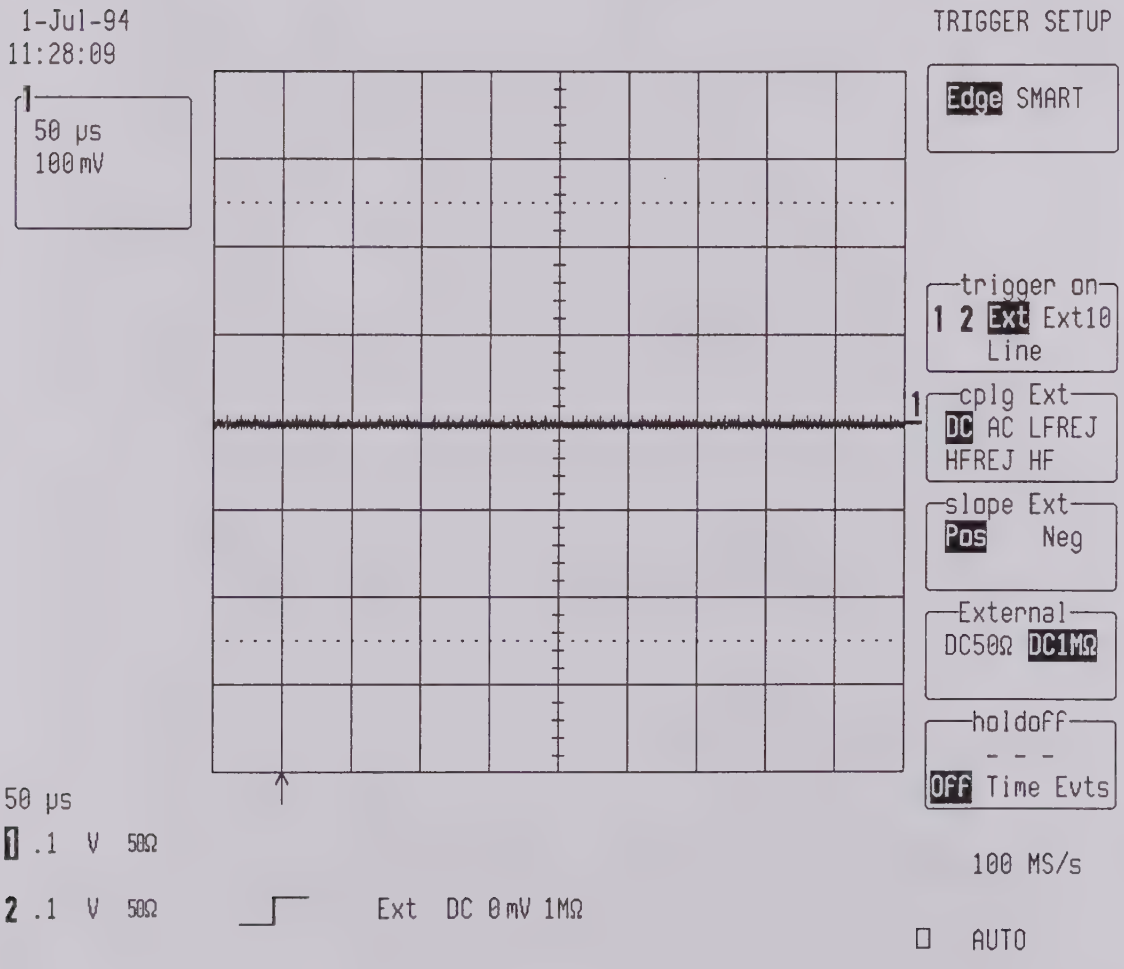
- Measure the impedance using a high precision DMM with sense : must be **50 Ω ± 1%**
- Repeat steps 3.4.1.a, and 3.4.1.b for Channel 2.

3.4.2 External Trigger Input Impedance

3.4.2.a DC 1MΩ

The External Trigger input impedance is tested with any time base and gain.

- Set Trigger on : **EXT**
- Trigger mode : **Auto**
- Coupling Ext : **DC**
- External : **DC 1MΩ**

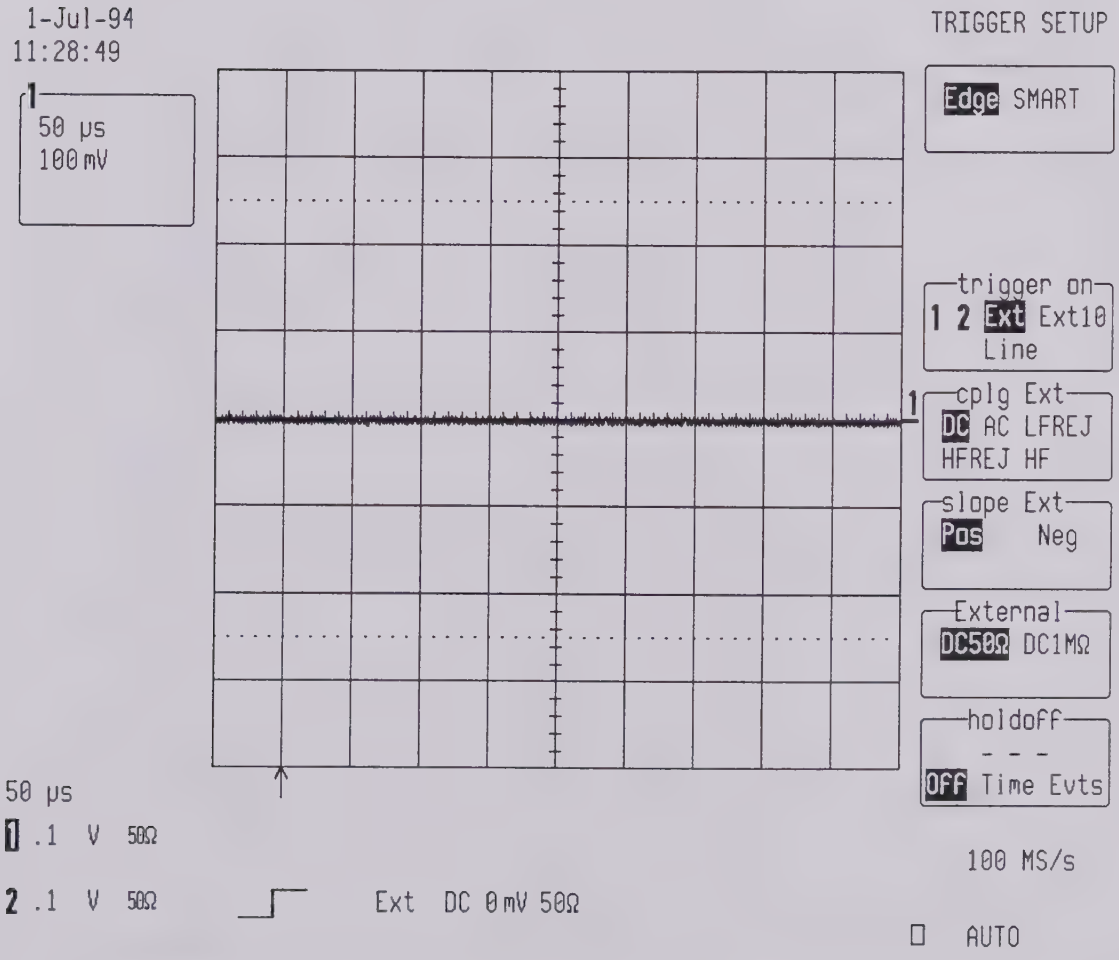


- Measure the impedance using a high precision DMM with sense : must be **1MΩ ±1%**.

3.4.2.b DC 50Ω

With any time base and gain.

- Set Trigger on : **EXT**
- Trigger mode : **Auto**
- Coupling Ext : **DC**
- External : **DC 50Ω**

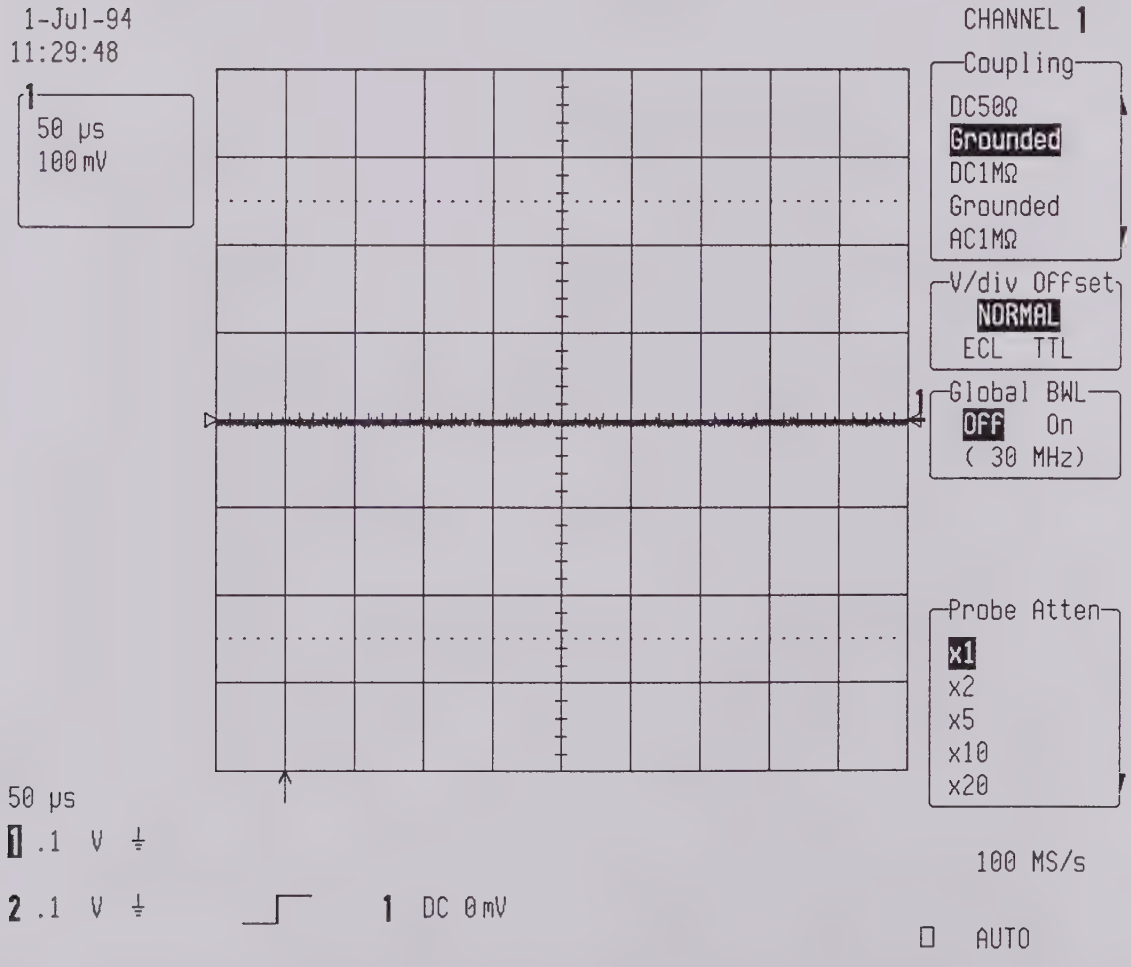


- Measure the impedance using a high precision DMM with sense : must be **50 Ω ± 1%**.
- Repeat steps 3.4.2.a, 3.4.2.b for **Ext/10**, and check as above.

3.4.3 Internal Protective Resistor Verification

With any time base and gain, set DSO as follows :

- Input Coupling : **Grounded**
- Check with a high precision DMM : input impedance must be **1 MΩ ± 2%**.
- In case of problem, see 9350/M/L service manual, or check SM 1MΩ resistor R3003, troubleshoot relay RL3000 .
- Repeat the above test for Channel 2.
- In case of problem check SM 1MΩ resistors R4003 or troubleshoot relay RL4000.



3.5 Leakage Current

Specifications

DC 1 MΩ, AC 1 MΩ, DC 50 Ω : ± 1 mV

3.5.1 Procedure

- Set DSO Ch1 : **On**
- Input Coupling : **DC 50Ω**
- Input gain : **100 mV/div.**
- Trigger on : **Channel 1**
- Trigger mode : **Auto**
- Time base : **10μsec**

- Connect a high precision DMM to Channel 1, and verify that the reading is not larger than ± **1 mV**.

- Repeat the procedure for **1MΩ DC** and **1MΩ AC**.

- Repeat step 3.5.1 for Channel 2 and check as above.

3.6 Average Noise Level

Description

The 9350/M/L inputs average noise level is tested at 5 mV/div., with 0 mV offset.
This is to verify the proper operation of the main board, front-end and ADC's.
The scope parameters functions are used to measure the RMS and Peak amplitude of the noise.

3.6.1 Peak to Peak Noise

Specifications

< ± 3.6 mV Peak to Peak at 5 mV/div.

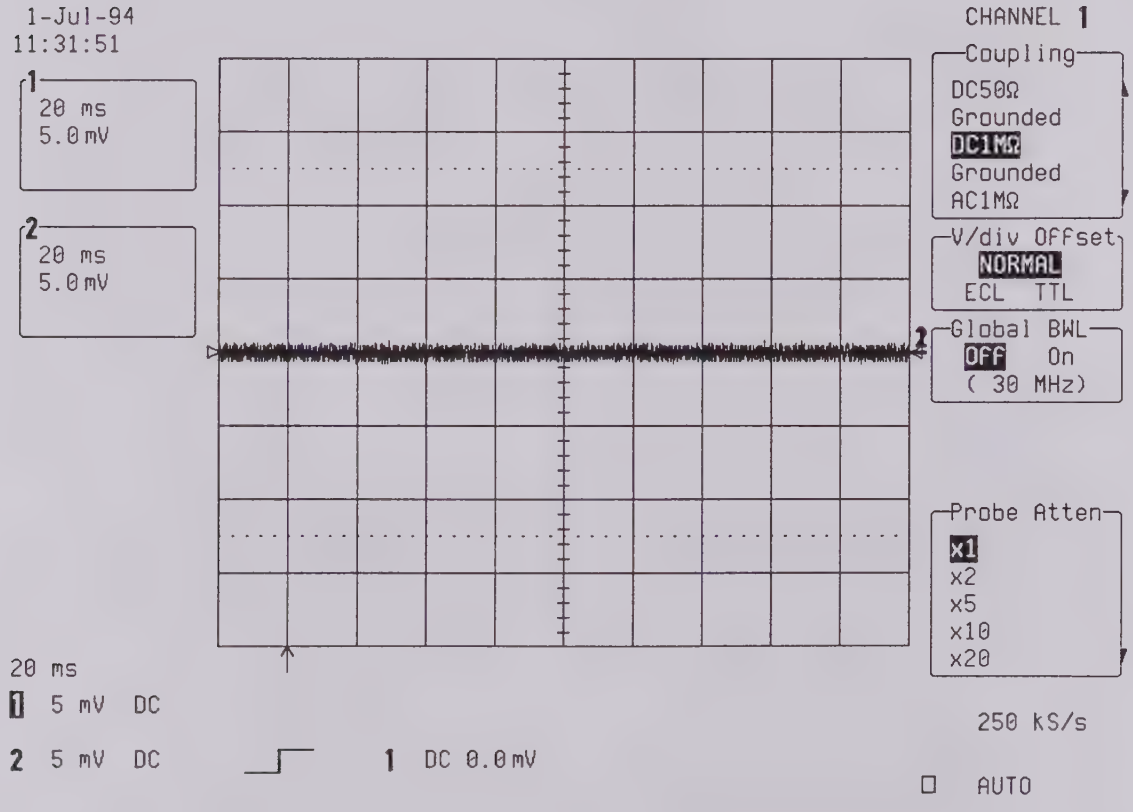
3.6.1.a DC 1MΩ

Procedure

- With no signal connected to the inputs, set 9350/M/L DSO settings as follows :

- Turn on traces : **Ch1, Ch2.**
- Display setup : **Standard, Dot Join on, Persistence off, Single grid**
- Input Coupling : **DC 1MΩ**
- V/div. offset : **Normal**
- Probe atten : **X1**
- Global BWL : **Off**

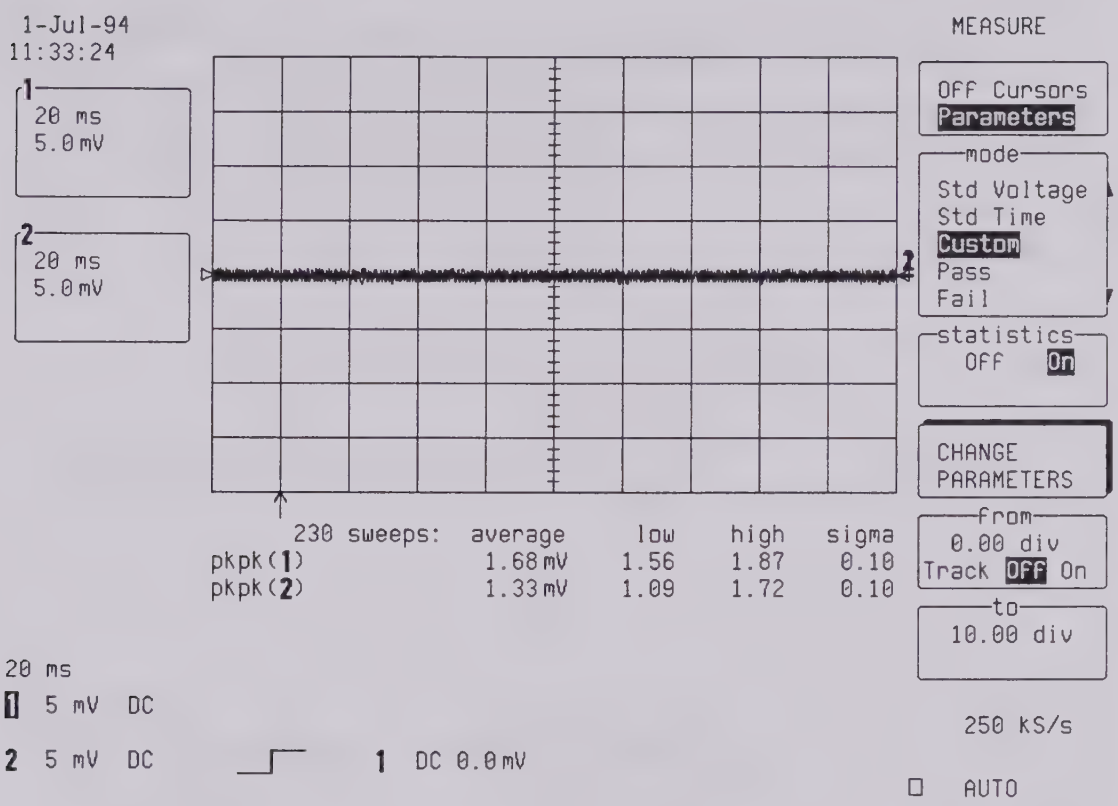
- Input gain : **5 mV/div.**
- Trigger setup : **Edge**
- Trigger on : **1**
- Coupling 1 : **DC**
- Slope 1 : **Pos**
- Holdoff : **Off**
- Trigger Mode : **Auto**
- Timebase : **20 msec/div.**
- Channel use : **2**
- Record up : **50 K**

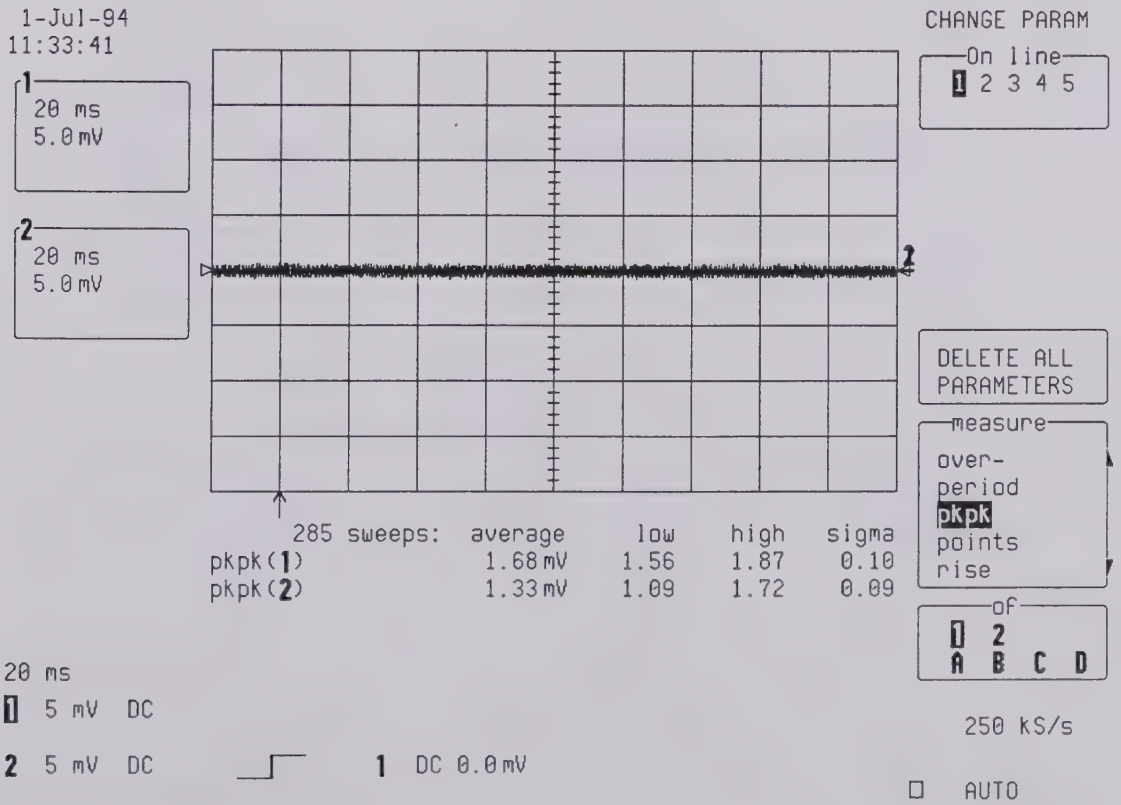


- Press : **Cursors/Measure**
- Measure : **Parameters**
- Mode : **Custom**
- Statistics : **On**

- Change parameters

- On line 1 : **Measure pkpk of Ch1**
- On line 2 : **Measure pkpk of Ch2**

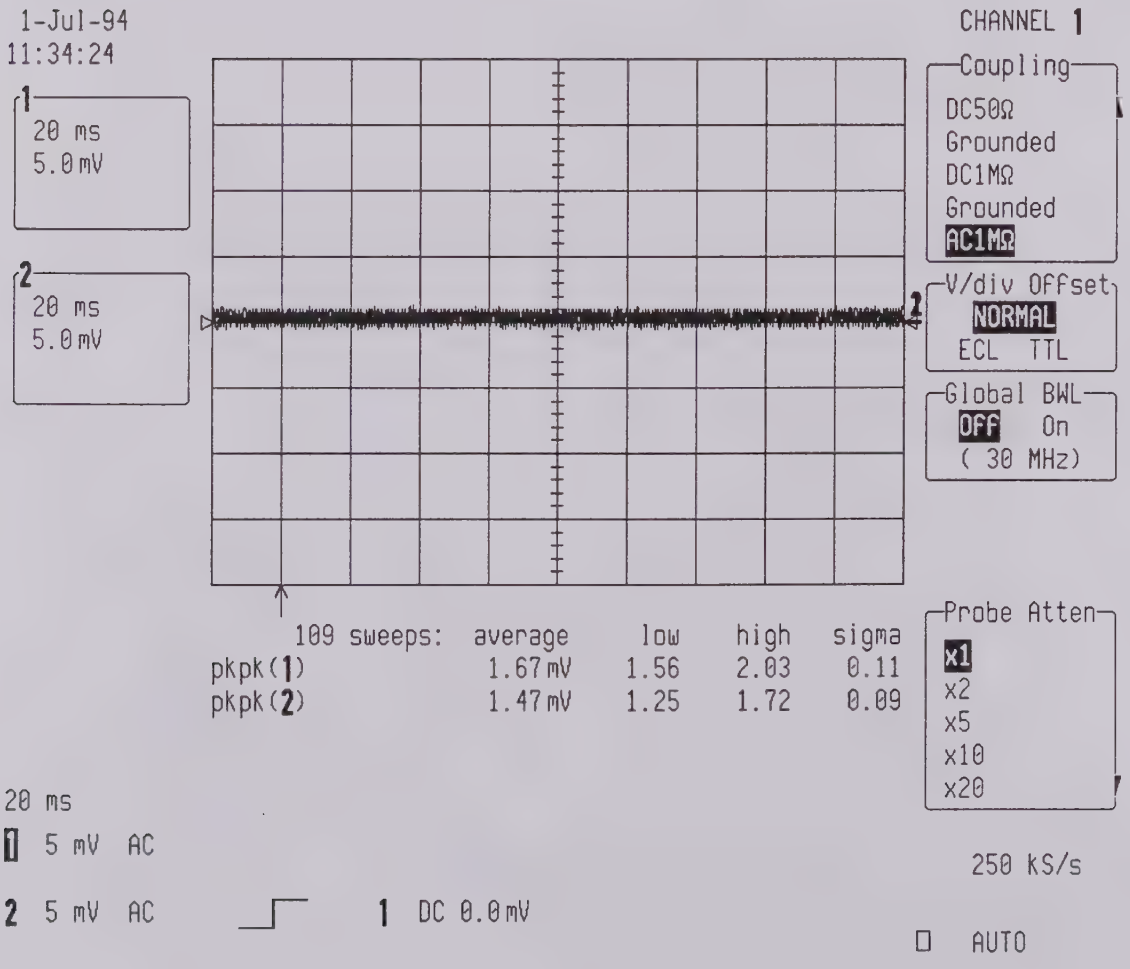

1-Jul-94
11:33:24
1
20 ms
5.0 mV
2
20 ms
5.0 mV
MEASURE
Off Cursors
Parameters
mode
Std Voltage
Std Time
Custom
Pass
Fail
statistics
Off On
CHANGE
PARAMETERS
230 sweeps: average low high sigma
pkpk(1) 1.68 mV 1.56 1.87 0.10
pkpk(2) 1.33 mV 1.09 1.72 0.10
from
0.00 div
Track Off On
to
10.00 div
20 ms
1 5 mV DC
2 5 mV DC
1 DC 0.0 mV
250 kS/s
AUTO


1-Jul-94
11:33:41
1
20 ms
5.0 mV
2
20 ms
5.0 mV
CHANGE PARAM
On line
1 2 3 4 5
DELETE ALL
PARAMETERS
measure
over-
period
pkpk
points
rise
of
1 2
A B C D
285 sweeps: average low high sigma
pkpk(1) 1.68 mV 1.56 1.87 0.10
pkpk(2) 1.33 mV 1.09 1.72 0.09
20 ms
1 5 mV DC
2 5 mV DC
1 DC 0.0 mV
250 kS/s
AUTO

- Check after at least 100 sweeps that : high pkpk readout is less than ± **3.6 mV**, corresponding to **9% of full scale**.
- Repeat the test for Timebase : **2 msec/div**, **.2 msec/div**, **20 µsec/div**, and **10 µsec/div.** and check as above.

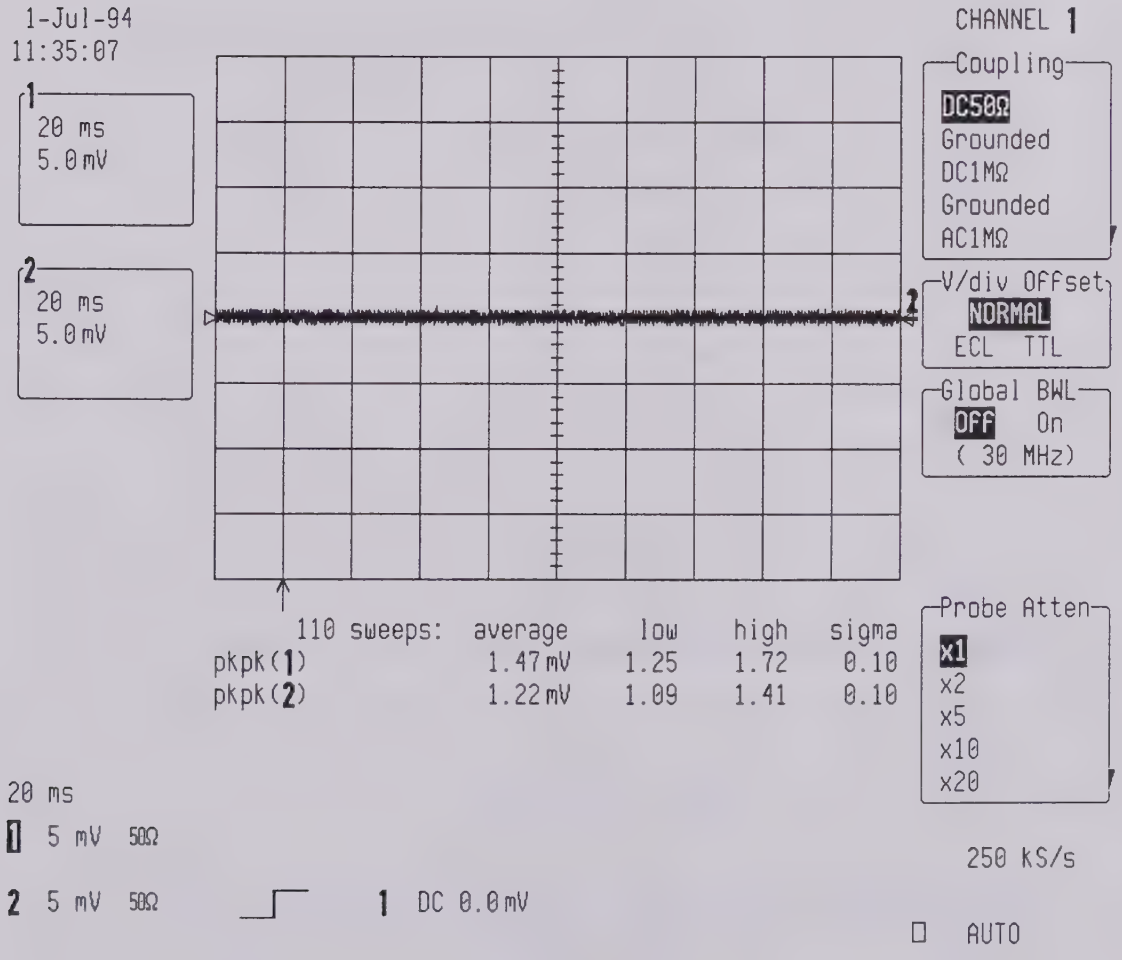
3.6.1.b AC 1MΩ

- Select Coupling Ch1, Ch2 : **AC 1MΩ**
- Check after at least 100 sweeps that the high pkpk readout is less than ± **3.6 mV**, corresponding to **9% of full scale**.
- Repeat the test for Timebase : **2 msec/div**, **.2 msec/div**, **20 µsec/div**, and **10 µsec/div.** and check as above.



3.6.1.c DC 50Ω

- Select Coupling Ch1, Ch2 : **DC 50Ω**
- Check after at least 100 sweeps that the high pkpk readout is less than **± 3.6 mV**, corresponding to **9% of full scale**.
- Repeat the tests for Timebase : **2 msec/div**, **.2 msec/div**, **20 µsec/div**, and **10 µsec/div.** and check as above.



3.6.2 Rms Noise

Specifications

< ± 360 μV at 5 mV/div.

3.6.2.a DC 1MΩ

Procedure

- With no signal connected to the inputs, set 9350/M/L DSO settings as follows :

- Turn on traces : **Ch1, Ch2**
- Display setup : **Standard, Dot Join on, Persistence off, Single grid**
- Input Coupling : **DC 1MΩ**
- V/div. offset : **Normal**
- Probe atten : **X1**
- Global BWL : **Off**
- Input gain : **5 mV/div.**
- Trigger setup : **Edge**
- Trigger on : **1**
- Coupling 1 : **DC**
- Slope 1 : **Pos**
- Holdoff : **Off**
- Trigger Mode : **Auto**
- Timebase : **20 msec/div.**
- Channel use : **2**
- Record up : **50 K**

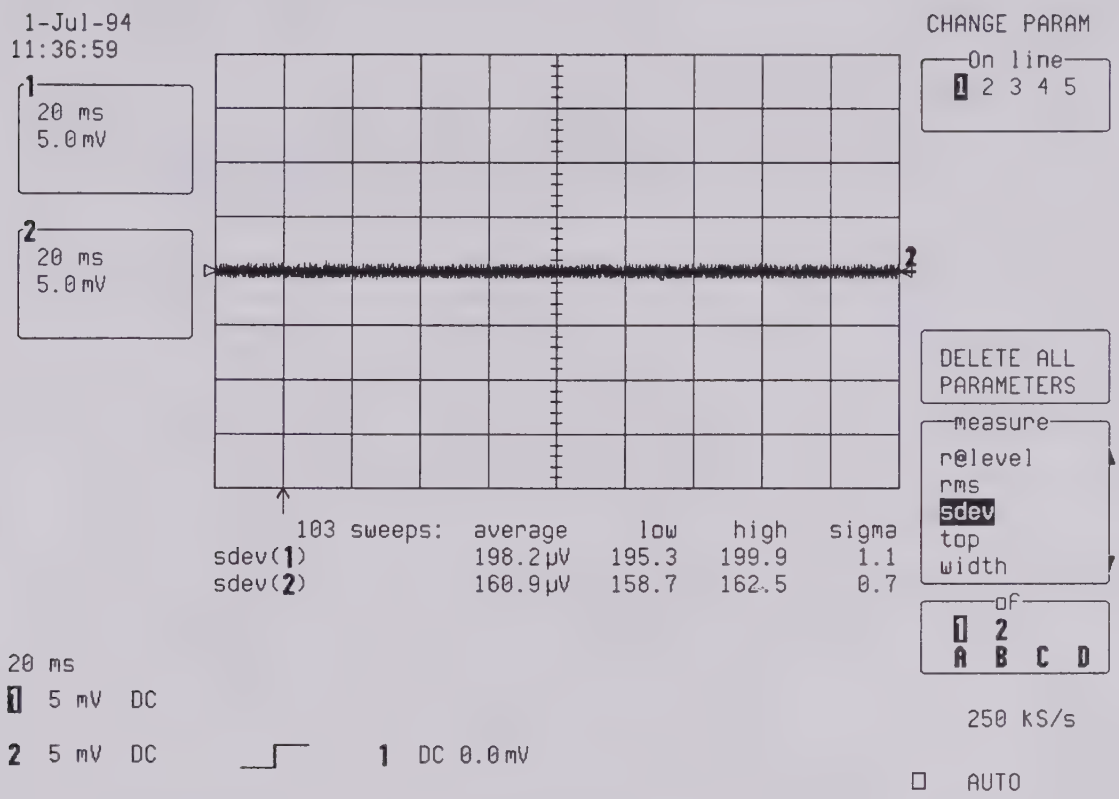
- Press : **Cursors/Measure**
- Measure : **Parameters**
- Mode : **Custom**
- Statistics : **On**

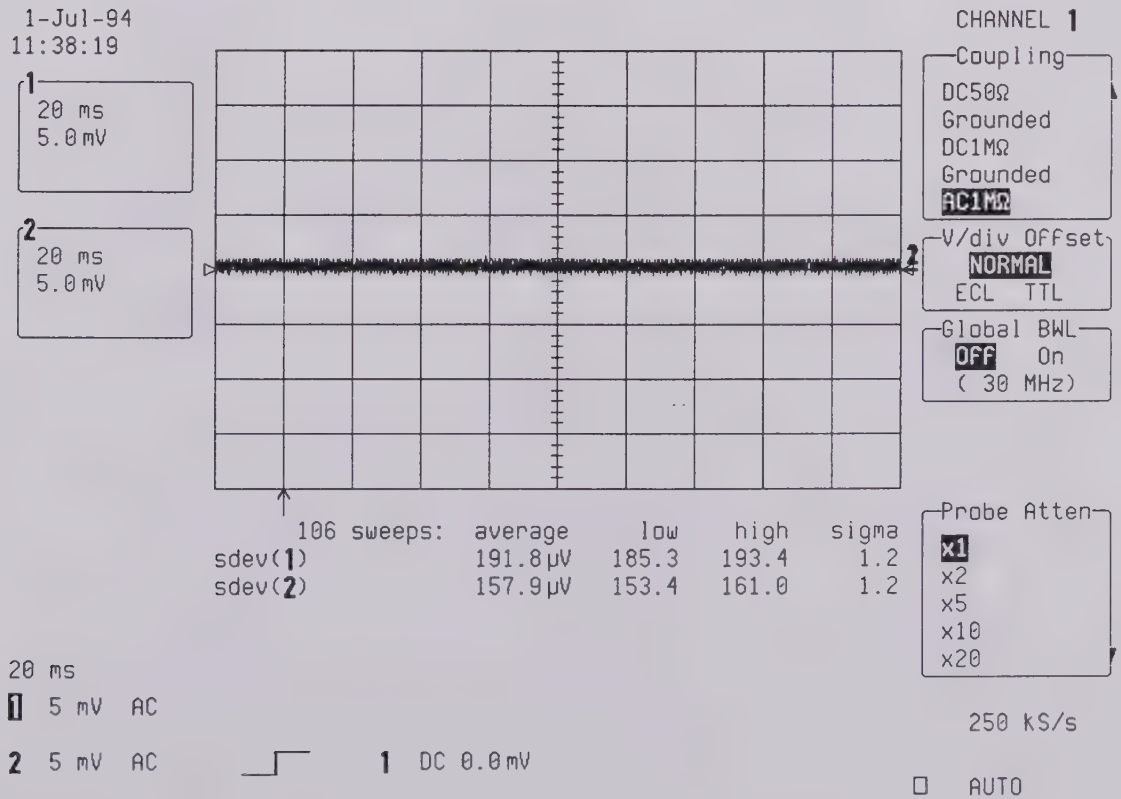
- Change parameters

- On line 1 : **Measure sdev of Ch1**
- On line 2 : **Measure sdev of Ch2**

- Check after at least 100 sweeps that : high sdev readout is less than **± 360 μV**, corresponding to **.9% of full scale**.

- Repeat the test for Timebase : **2 msec/div**, **.2 msec/div**, **20 μsec/div**, and **10 μsec/div.** and check as above.


1-Jul-94
11:36:59
1
20 ms
5.0 mV
2
20 ms
5.0 mV
CHANGE PARAM
On line
1 2 3 4 5
DELETE ALL
PARAMETERS
measure
r@level
rms
sdev
top
width
of
1 2
A B C D
103 sweeps: average low high sigma
sdev(1) 198.2 µV 195.3 199.9 1.1
sdev(2) 160.9 µV 158.7 162.5 0.7
20 ms
1 5 mV DC
2 5 mV DC
1 DC 0.0 mV
250 kS/s
AUTO

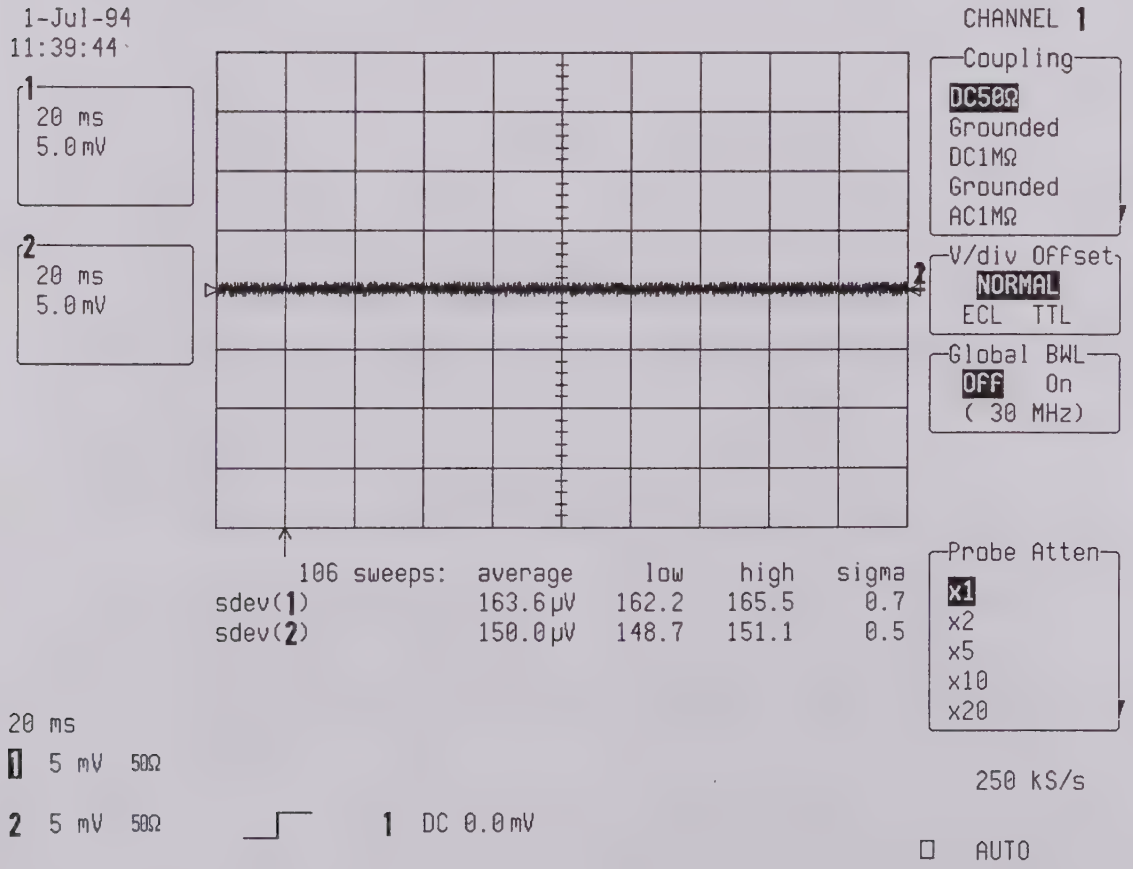

1-Jul-94
11:38:19
1
20 ms
5.0 mV
2
20 ms
5.0 mV
CHANNEL 1
Coupling
DC50Ω
Grounded
DC1MΩ
Grounded
AC1MΩ
V/div Offset
NORMAL
ECL TTL
Global BWL
OFF On
(30 MHz)
Probe Atten
x1
x2
x5
x10
x20
106 sweeps: average low high sigma
sdev(1) 191.8 µV 185.3 193.4 1.2
sdev(2) 157.9 µV 153.4 161.0 1.2
20 ms
1 5 mV AC
2 5 mV AC
1 DC 0.0 mV
250 kS/s
AUTO

3.6.2.b AC 1MΩ

- Select Coupling Ch1, Ch2 : **AC 1MΩ**
- Check after at least 100 sweeps that the high pkpk readout is less than **± 360 µV**, corresponding to **.9% of full scale**.
- Repeat the test for Timebase : **2 msec/div**, **.2 msec/div**, **20 µsec/div**, and **10 µsec/div.** and check as above.

3.6.2.c DC 50Ω

- Select Coupling Ch1, Ch2 : **DC 50Ω**
- Check after at least 100 sweeps that the high pkpk readout is less than **± 360 µV**, corresponding to **.9% of full scale**.
- Repeat the tests for Timebase : **2 msec/div**, **.2 msec/div**, **20 µsec/div**, and **10 µsec/div.** and check as above.



3.6.3 Inputs Grounded

With no cable plugged into scope, set the DSO as follows :

- Turn on trace : **Channel 1, Channel 2**
- Input Coupling : **DC 50Ω**
- Input gain : **10 mV/div.**
- Offset : **Zero**
- Trigger on : **Channel 1, DC**
- Trigger mode : **Auto**
- Timebase : **50 μsec/div.**
- Channel use : **2**
- Record up : **50 K**
- Turn off trace : **Channel 1, Channel 2**

- Turn on trace : **A, B**
- Select Math Setup
- For Math : **Use at most 5000 points**
- Redefine A, B : **Channel 1, Channel 2**
- Use Math ? : **Yes**
- Math Type : **Average**
- Avg Type : **Summed**
- For : **1000 sweeps**

- Cursors/Measure : **Parameters**
- Mode : **Custom**
- Statistics : **off**
- Change parameters
- On line 1 : **Measure mean of A**
- On line 2 : **Measure mean of B**

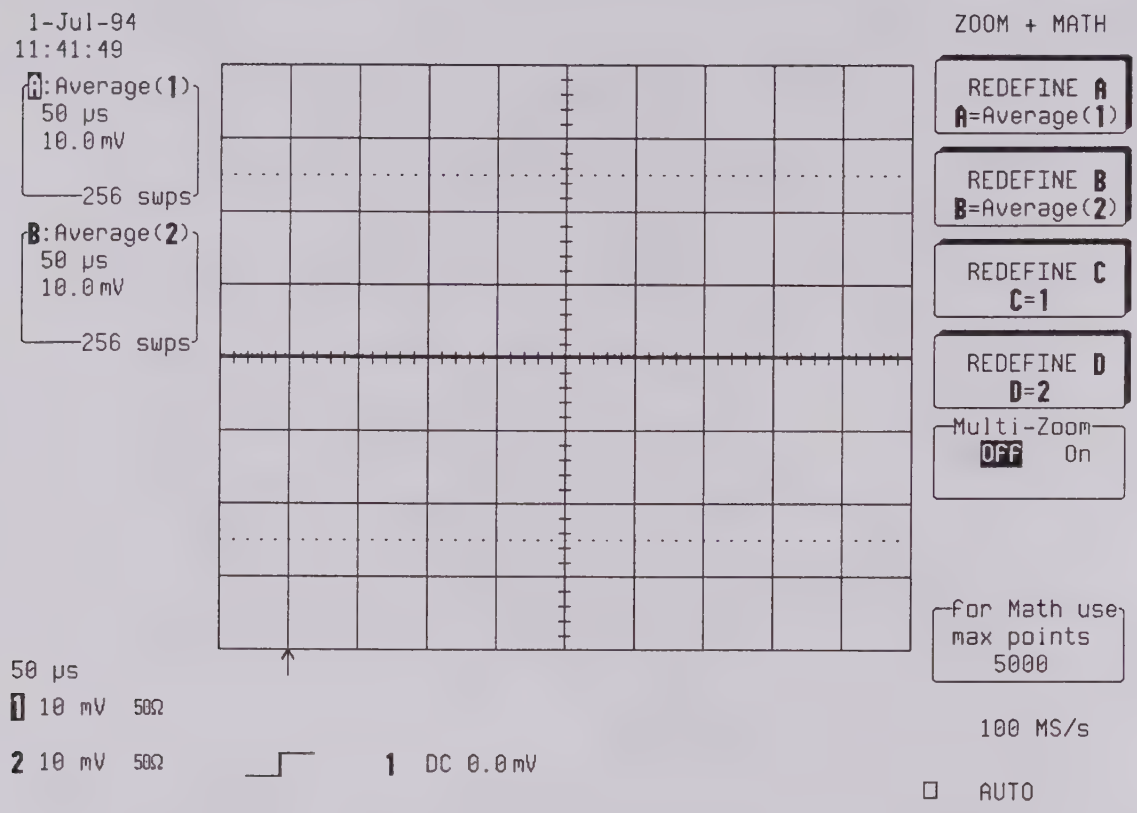
- Check after at least 100 sweeps that the **mean** value of **A**, **B** is less than **±1.6 mV,** corresponding to ± 2% of full scale.

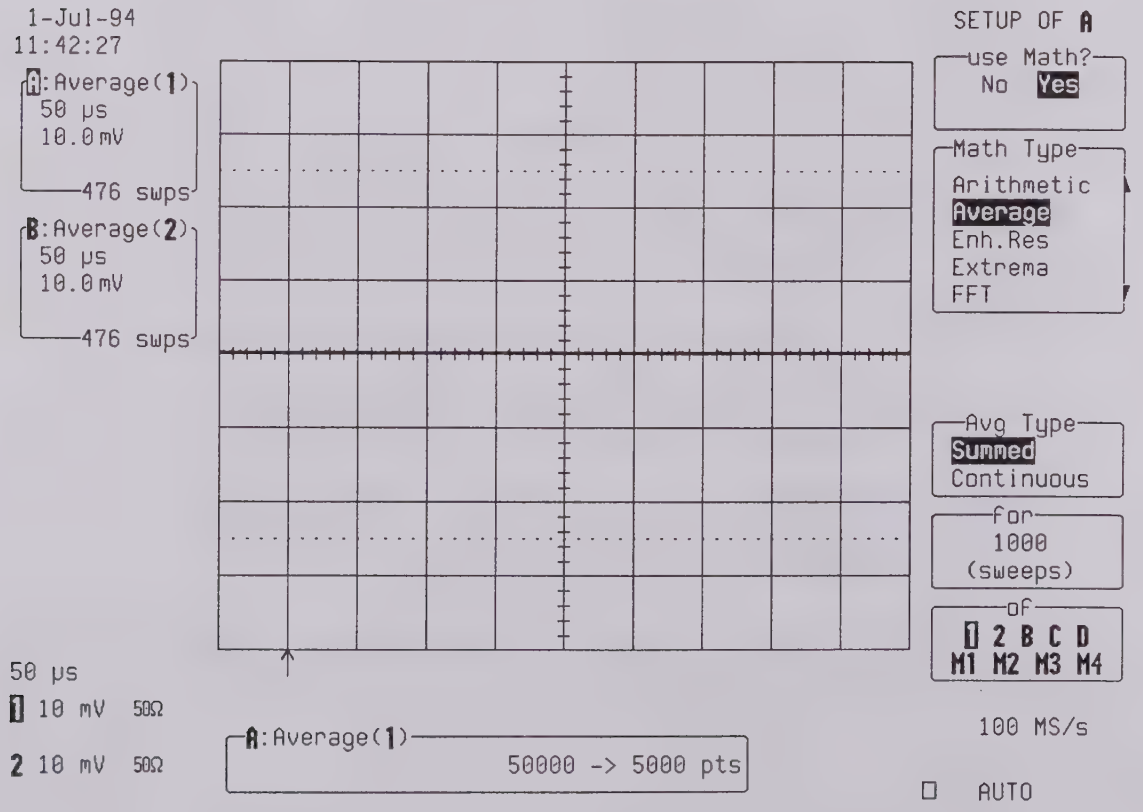
- Switch Channel 1 and Channel 2 between coupling **DC 50Ω** and **Grounded**.

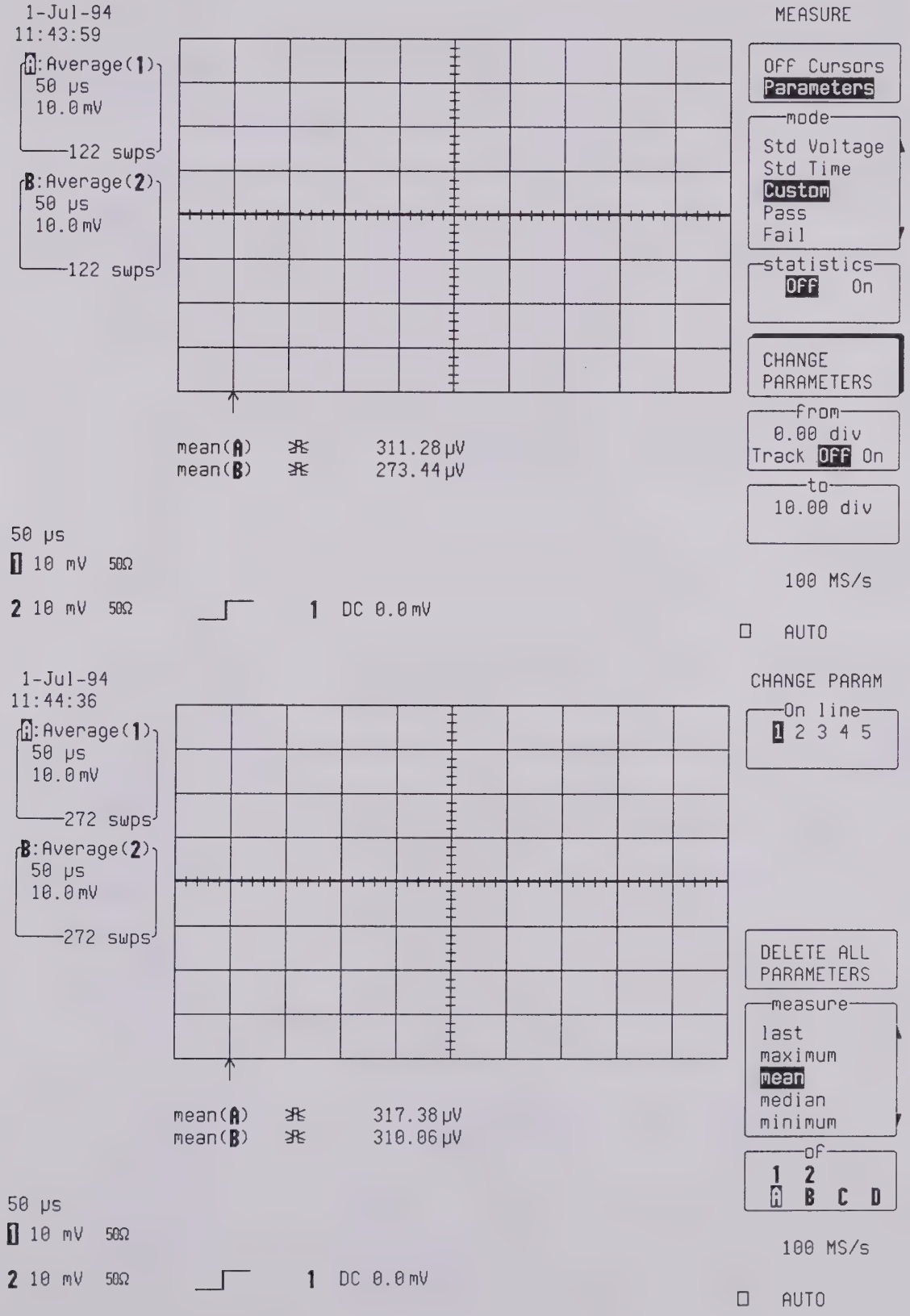
- Check after at least 100 sweeps that the **mean** value of **A**, **B** is less than **±1.6 mV,** corresponding to ± 2% of full scale.

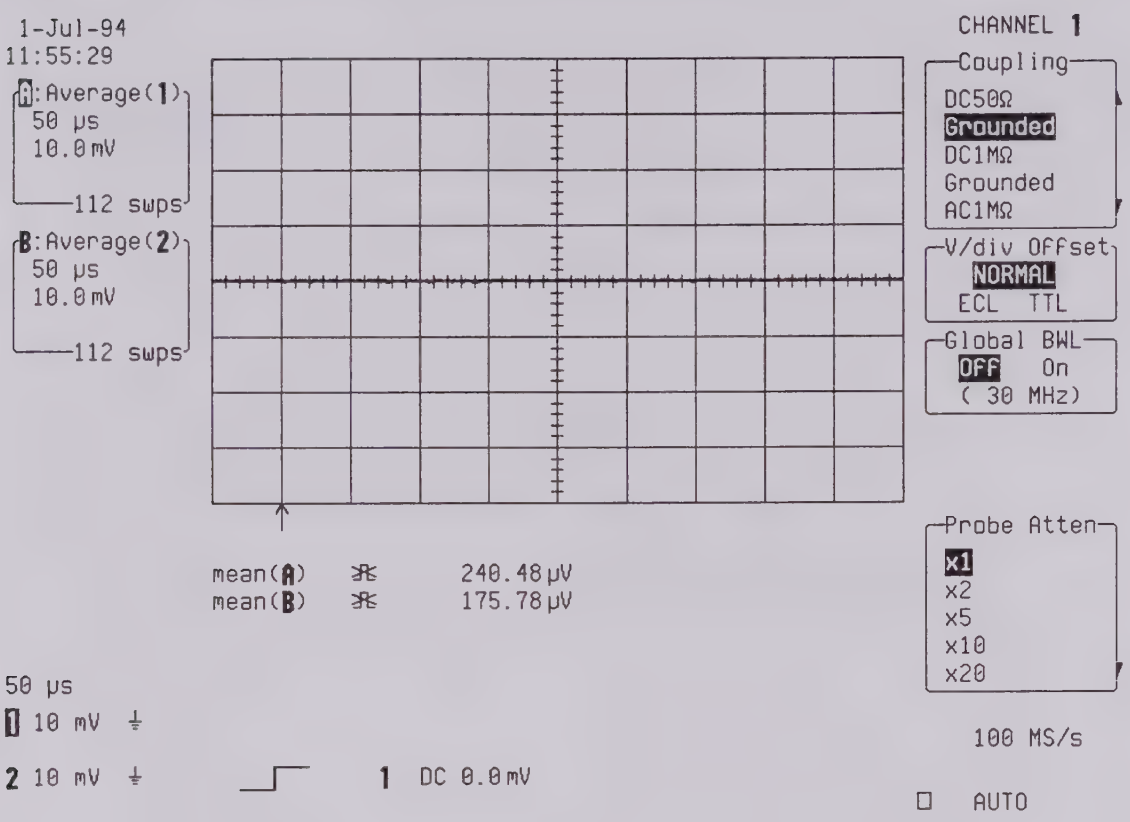
- Set coupling all Channel : **DC 1MΩ**
- Check after at least 100 sweeps that the **mean** value of **A**, **B** is less than **±1.6 mV,** corresponding to ± 2% of full scale.

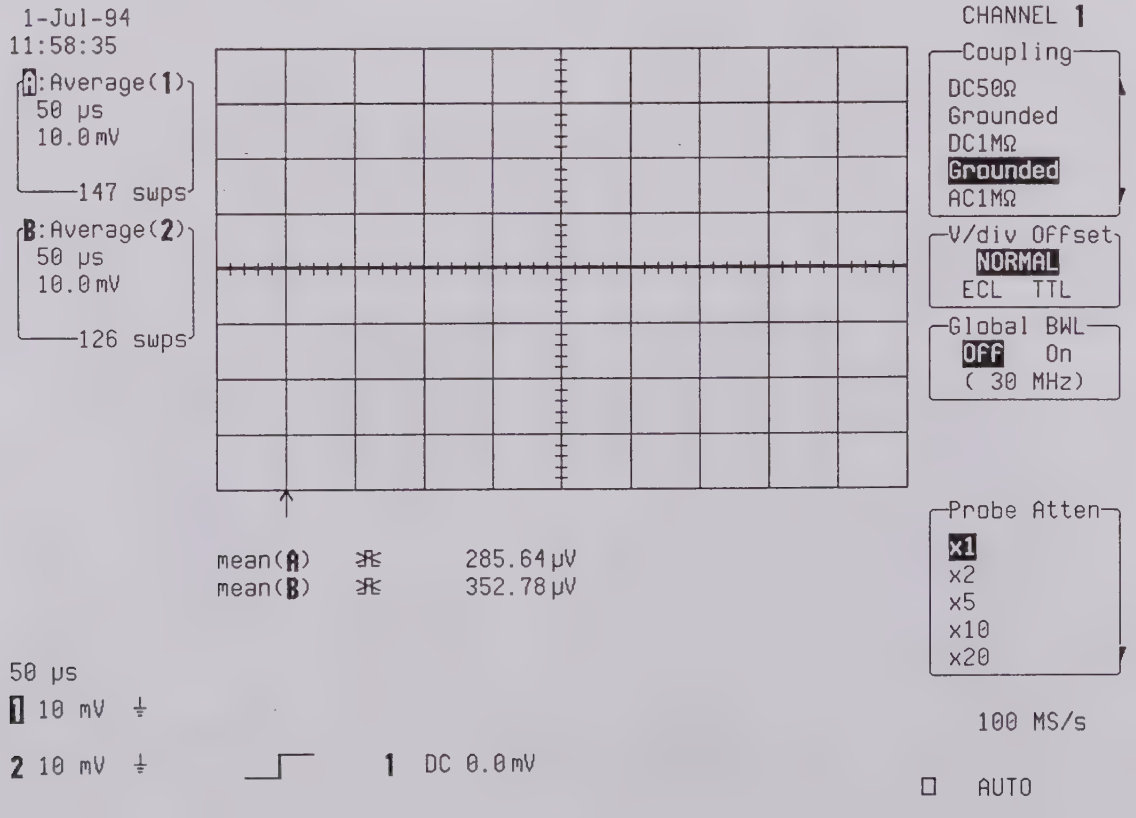
- Switch Channel 1 and Channel 2 between coupling **DC 1MΩ and Grounded**.
- Check after at least 100 sweeps that the **mean** value of **A**, **B** is less than **±1.6 mV,** corresponding to ± 2% of full scale.


1-Jul-94
11:41:49
A:Average(1)
50 µs
10.0 mV
256 swps
B:Average(2)
50 µs
10.0 mV
256 swps
ZOOM + MATH
REDEFINE A
A=Average(1)
REDEFINE B
B=Average(2)
REDEFINE C
C=1
REDEFINE D
D=2
Multi-Zoom
OFF On
for Math use
max points
5000
50 µs
1 10 mV 50Ω
2 10 mV 50Ω
1 DC 0.0 mV
100 MS/s
AUTO


1-Jul-94
11:42:27
A:Average(1)
50 µs
10.0 mV
476 swps
B:Average(2)
50 µs
10.0 mV
476 swps
SETUP OF A
use Math?
No Yes
Math Type
Arithmetic
Average
Enh.Res
Extrema
FFT
Avg Type
Summed
Continuous
for
1000
(sweeps)
of
1 2 B C D
M1 M2 M3 M4
50 µs
1 10 mV 50Ω
2 10 mV 50Ω
A:Average(1)
50000 -> 5000 pts
100 MS/s
AUTO


1-Jul-94
11:43:59
A:Average(1)
50 µs
10.0 mV
122 swps
B:Average(2)
50 µs
10.0 mV
122 swps
MEASURE
Off Cursors
Parameters
mode
Std Voltage
Std Time
Custom
Pass
Fail
statistics
Off On
CHANGE PARAMETERS
from
0.00 div
Track Off On
to
10.00 div
mean(A) 311.28 µV
mean(B) 273.44 µV
50 µs
1 10 mV 50Ω
2 10 mV 50Ω
1 DC 0.0 mV
100 MS/s
AUTO
1-Jul-94
11:44:36
A:Average(1)
50 µs
10.0 mV
272 swps
B:Average(2)
50 µs
10.0 mV
272 swps
CHANGE PARAM
On line
1 2 3 4 5
DELETE ALL PARAMETERS
measure
last
maximum
mean
median
minimum
of
1 2
A B C D
mean(A) 317.38 µV
mean(B) 310.06 µV
50 µs
1 10 mV 50Ω
2 10 mV 50Ω
1 DC 0.0 mV
100 MS/s
AUTO


1-Jul-94
11:55:29
A:Average(1)
50 µs
10.0mV
112 swps
B:Average(2)
50 µs
10.0mV
112 swps
CHANNEL 1
Coupling
DC50Ω
Grounded
DC1MΩ
Grounded
AC1MΩ
V/div Offset
NORMAL
ECL TTL
Global BWL
OFF On
(30 MHz)
Probe Atten
x1
x2
x5
x10
x20
mean(A) 240.48µV
mean(B) 175.78µV
50 µs
1 10 mV
2 10 mV
1 DC 0.0mV
100 MS/s
AUTO


1-Jul-94
11:58:35
A:Average(1)
50 µs
10.0mV
147 swps
B:Average(2)
50 µs
10.0mV
126 swps
CHANNEL 1
Coupling
DC50Ω
Grounded
DC1MΩ
Grounded
AC1MΩ
V/div Offset
NORMAL
ECL TTL
Global BWL
OFF On
(30 MHz)
Probe Atten
x1
x2
x5
x10
x20
mean(A) 285.64µV
mean(B) 352.78µV
50 µs
1 10 mV
2 10 mV
1 DC 0.0mV
100 MS/s
AUTO

3.7 DC Linearity

Specification

≤ ± 2 % of full scale at 0 mV offset

3.7.1 Description

This test measures the DC Accuracy within the gain range specified.
The parameters Std voltage are used to measure the amplitude of the DC input signal.

In the absence of the computer automated calibration system based on LeCroy Calibration Software (LeCalsoft) for the 9350/M/L model oscilloscope, the manual performance test procedure can be followed to establish a traceable calibration, provided that the measurement instruments used are themselves traceable.
For such calibration, follow the manual linearity test procedure using a calibrated and certified high precision (better than 0.1 %) voltage source, for example TEK PS5004 or equivalent, or use a certified DMM to measure the applied voltage.

3.7.1.a DC 50Ω

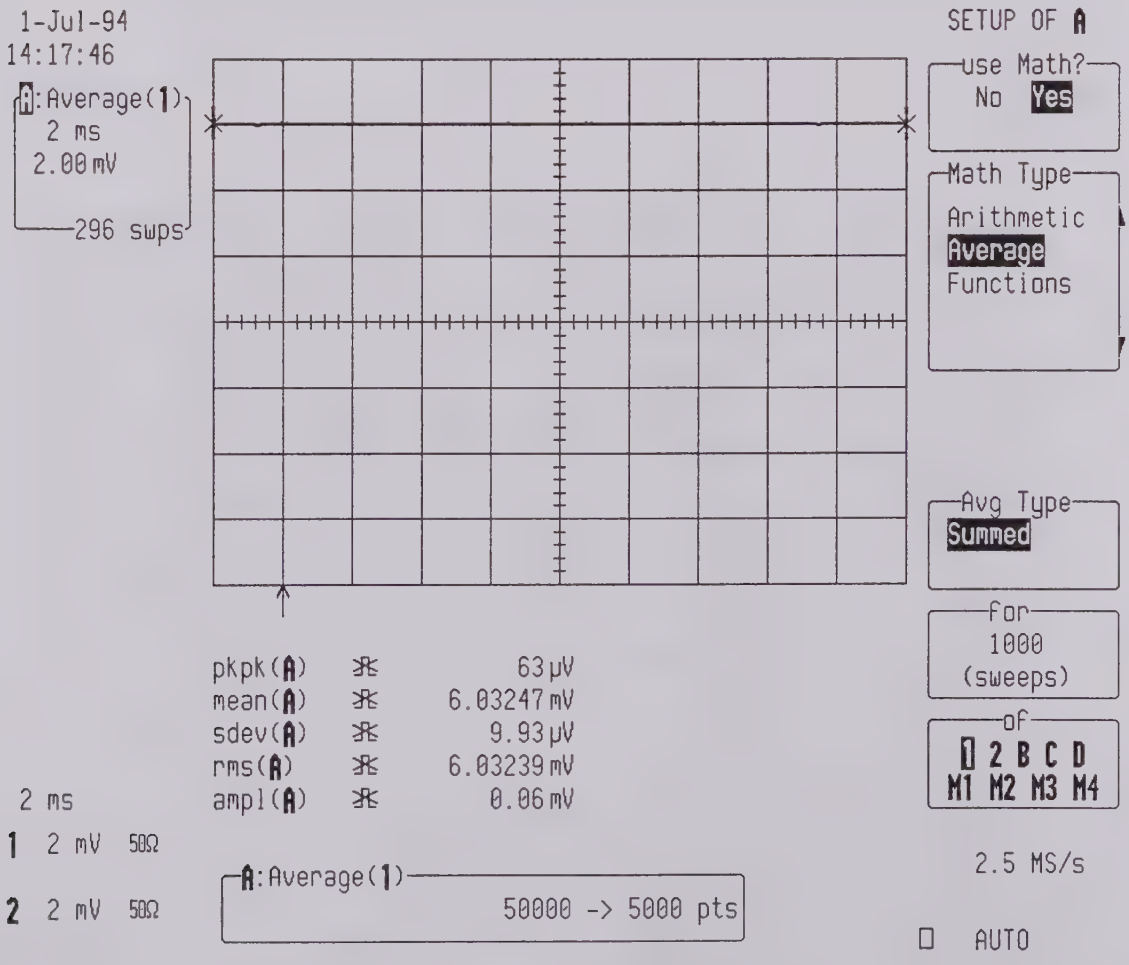
Procedure

- Turn on trace : **Ch1**
- Display setup : **Standard, Persistence off, Dot join on, Single grid**
- Input Coupling : **DC 50 Ω**
- V/div. offset : **Normal**
- Global BWL : **Off**
- Probe atten : **X1**
- Input offset : **0.0 mV**
- Input gain : **from 2mV/div to 5 V/div.** (see table 3-2 and 3-3)
- Trigger setup : **Edge**
- Trigger on : **1**
- Coupling 1 : **DC**
- Slope 1 : **Pos**
- Mode : **Auto**
- Holdoff : **Off**
- Timebase : **2 msec/div.**
- Channel use : **2**
- Record up : **50 K**
- Turn on trace : **A**
- Select Math Setup
- For Math : **Use at most 5000 points**
- Redefine A
- Use Math ? : **Yes**
- Math Type : **Average**
- Avg Type : **Summed**
- For : **1000 sweeps**
- Of : **Channel 1**

- Turn off trace : **Channel 1**
- Cursors/Measure : **Parameters**
- Mode : **Std Voltage**
- Statistics : **off**
- on displayed trace : **A**

3.7.1.a.1 Positive DC Linearity

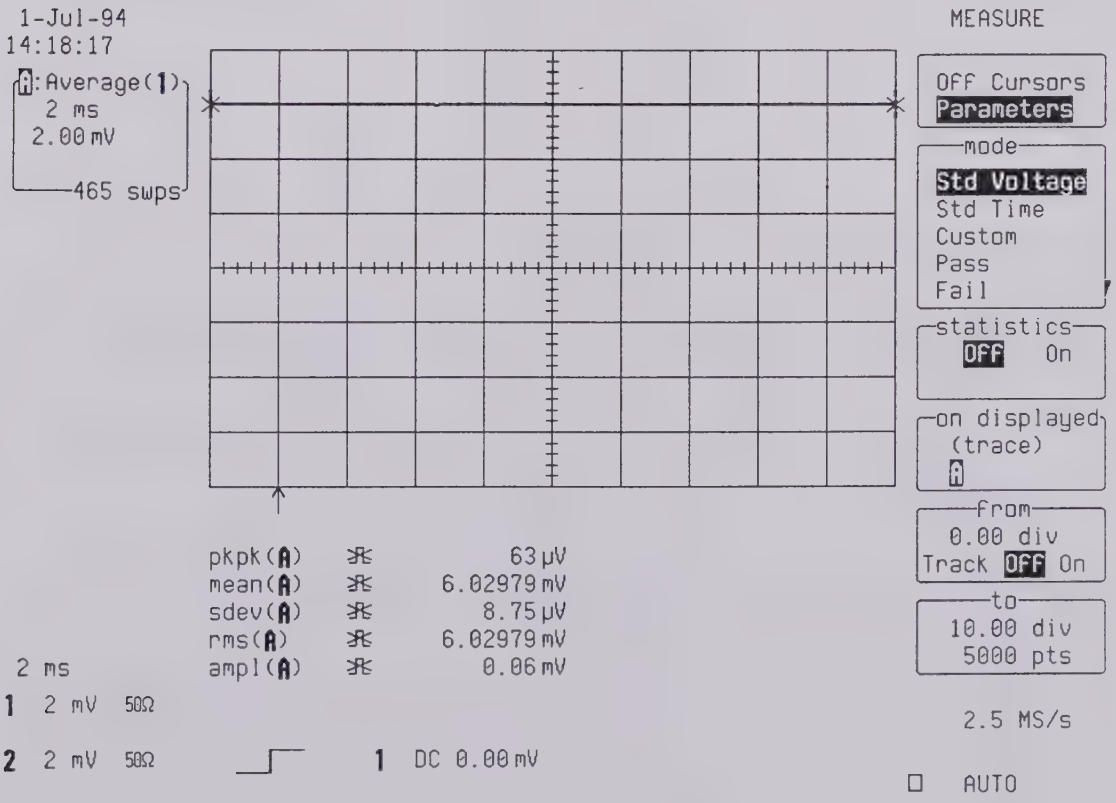
- For the ranges **2 mV/div. to 1 V/div.**, from the high precision voltage source, apply to Channel 1 : **+ 3 major screen divisions**.
- For the low sensitivities : **2 mV, 5 mV, 10 mV, 20 mV** and **50 mV/div.**, use a **50 Ohm 20 dB** attenuator.
- For the range **2V/div. and 5V/div.**, the maximum input voltage is **+ 5 V**.

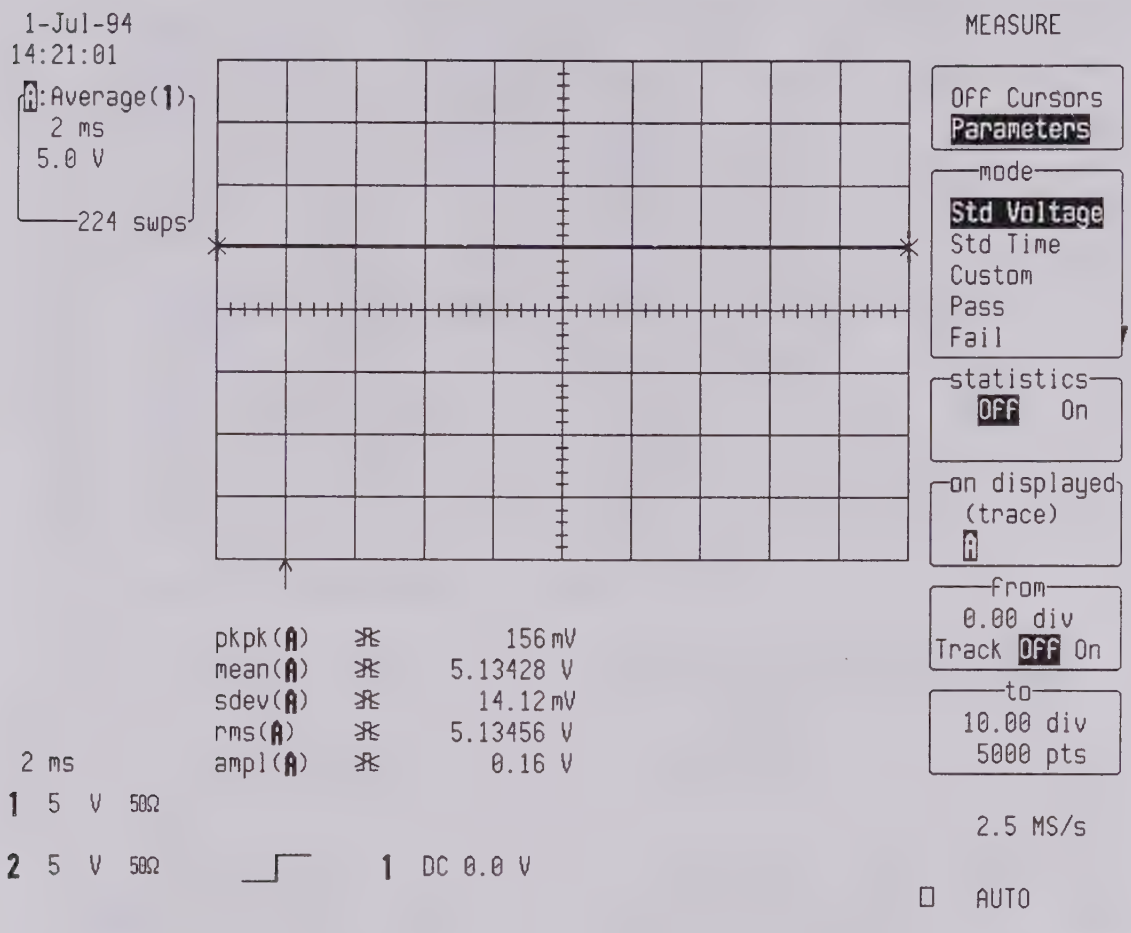


Range	Attenuator	Conditions of Test			Average Mean Parameter Reading		
Volt/div Control	20 dB	PS Output	9350/M/L Input	9350/M/L Full scale	Min Value -X % of FS	Max Value +X% of FS	X%
2 mV	Yes	+ 60 mV	+ 6 mV	16 mV	+ 5.2 mV	+ 6.8 mV	5%
5 mV	Yes	+ 150 mV	+ 15 mV	40 mV	+ 13.8 mV	+ 16.2 mV	3%
10 mV	Yes	+ 300 mV	+ 30 mV	80 mV	+ 28.4 mV	+ 31.6 mV	2%
20 mV	Yes	+ 600 mV	+ 60 mV	160 mV	+ 56.8 mV	+ 63.2 mV	2%
50 mV	Yes	+ 1.5 V	+150 mV	400 mV	+ 142 mV	+ 158 mV	2%
.1 V	No	+ 300 mV	+ 300 mV	800 mV	+ 284 mV	+ 316 mV	2%
.2 V	No	+ 600 mV	+ 600 mV	1.6 v	+ 568 mV	+ 632 mV	2%
.5 V	No	+ 1.5 V	+ 1.5 V	4 V	+ 1.42 V	+ 1.58 V	2%
1 V	No	+ 3 V	+ 3 V	8 V	+ 2.84 V	+ 3.16 V	2%
2 V	No	Max +5 V	Max +5 V	16 V	+ 4.68 V	+ 5.32 V	2%
5 V	No	Max +5 V	Max +5 V	40 V	+ 4.20 V	+ 5.80 V	2%

Table 3-2 : Positive DC Linearity Readout Accuracy

- For each point, read off the **Mean** parameter voltage, and compare it to the digital readout of the voltage reference
- The **Mean** parameter reading should be within the limits shown in table 3-2.



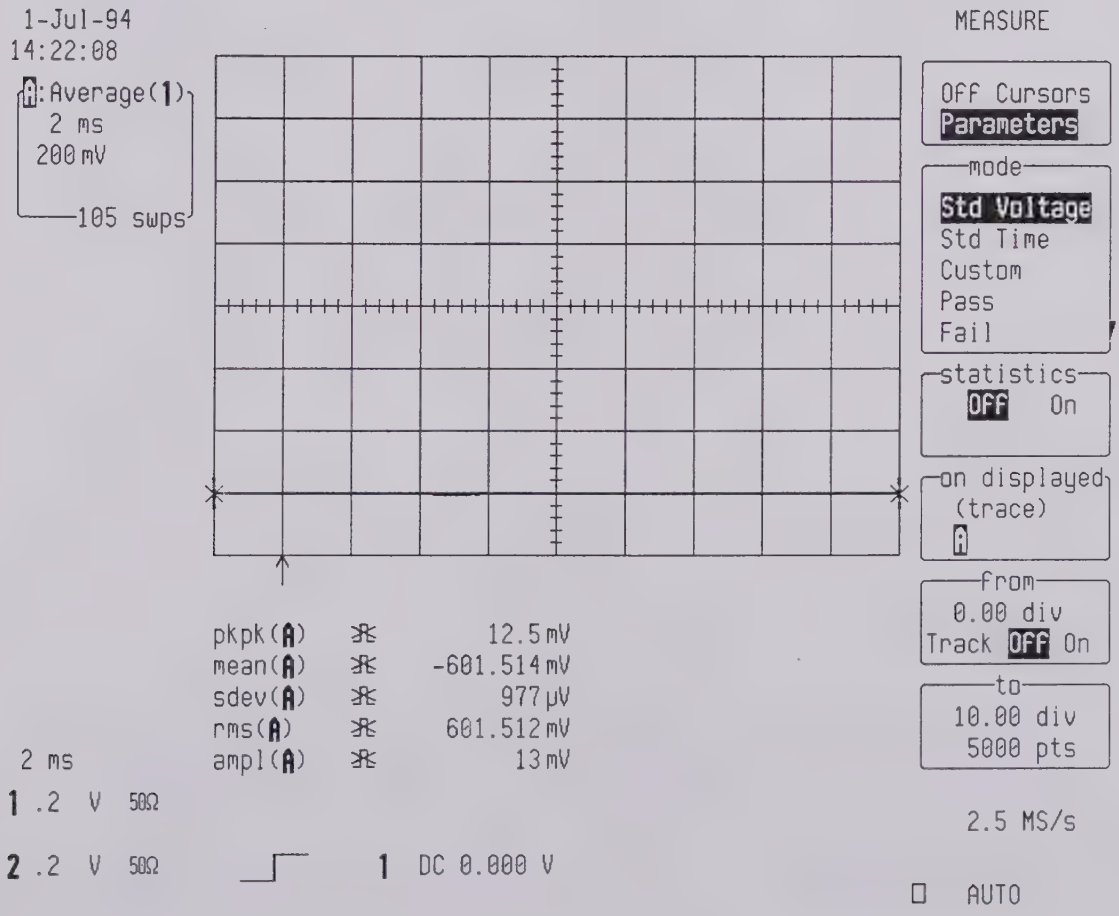


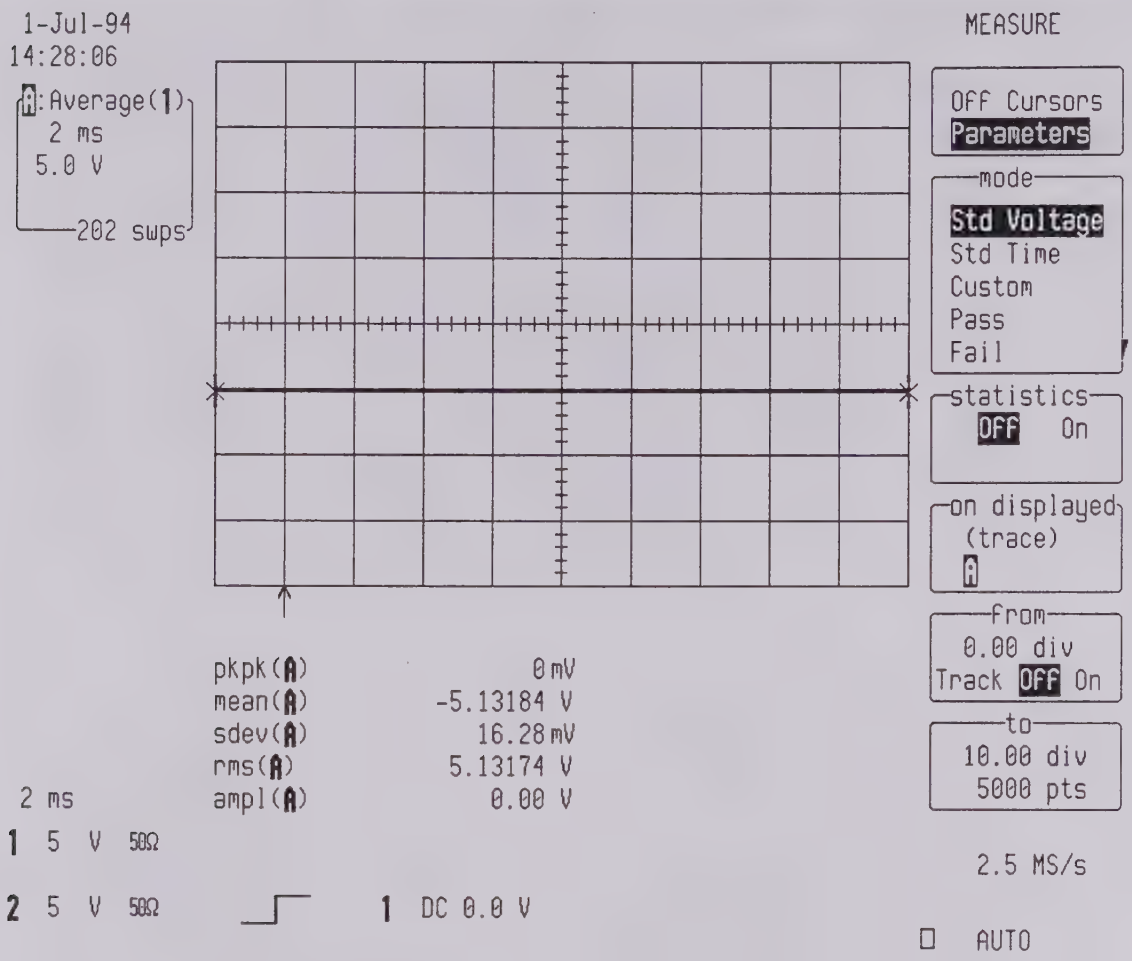
3.7.1.a.2 Negative DC Linearity

- For the ranges **2 mV/div. to 1 V/div.**, from the high precision voltage source, apply to Channel 1 : **- 3 major screen divisions**.
- For the low sensitivities : **2 mV, 5 mV, 10 mV, 20 mV** and **50 mV/div.**, use a **50Ω 20 dB** attenuate.
- For the range **2V/div. and 5V/div.,** the minimum input voltage is **- 5 V**.
- For each point, read off the **Mean** parameter voltage, and compare it to the digital readout of the voltage reference.
- The **mean** parameter reading should be within the limits shown in table 3-3.

Range	Attenuator	Conditions of Test			Average Mean Parameter Reading		
Volt/div Control	20 dB	PS Output	9350/M/L Input	9350/M/L Full scale	Min Value -X % of FS	Max Value +X% of FS	X%
2 mV	Yes	- 60 mV	- 6 mV	16 mV	- 5.2 mV	- 6.8 mV	5%
5 mV	Yes	- 150 mV	- 15 mV	40 mV	- 13.8 mV	- 16.2 mV	3%
10 mV	Yes	- 300 mV	- 30 mV	80 mV	- 28.4 mV	- 31.6 mV	2%
20 mV	Yes	- 600 mV	- 60 mV	160 mV	- 56.8 mV	- 63.2 mV	2%
50 mV	Yes	- 1.5 V	-150 mV	400 mV	- 142 mV	- 158 mV	2%
.1 V	No	- 300 mV	- 300 mV	800 mV	- 284 mV	- 316 mV	2%
.2 V	No	- 600 mV	- 600 mV	1.6 v	- 568 mV	- 632 mV	2%
.5 V	No	- 1.5 V	- 1.5 V	4 V	- 1.42 V	- 1.58 V	2%
1 V	No	- 3 V	- 3 V	8 V	- 2.84 V	- 3.16 V	2%
2 V	No	Max -5 V	Max -5 V	16 V	- 4.68 V	- 5.32 V	2%
5 V	No	Max -5 V	Max -5 V	40 V	- 4.20 V	- 5.80 V	2%

Table 3-3 : Negative DC Linearity Readout Accuracy





3.7.1.b DC 1MΩ

Set the DSO as follows :

- Input Coupling : **DC 1MΩ**
- Input offset : **0.0 mV**
- Input gain : **from 2mV/div. to 5 V/div.**

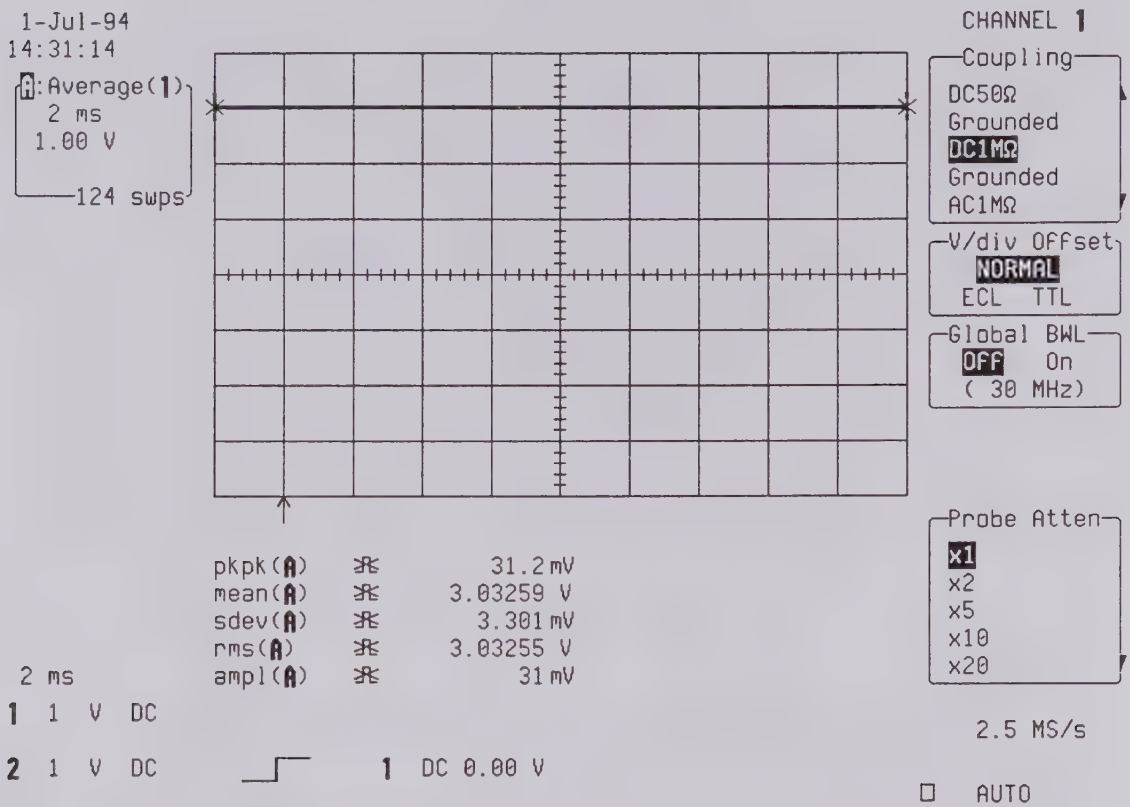
- For the ranges **2 mV/div. to 5 V/div.**, from the high precision voltage source, apply to Channel 1 the following 2 voltages values, one after another : **+ 3 major** screen divisions, **- 3 major** screen divisions.

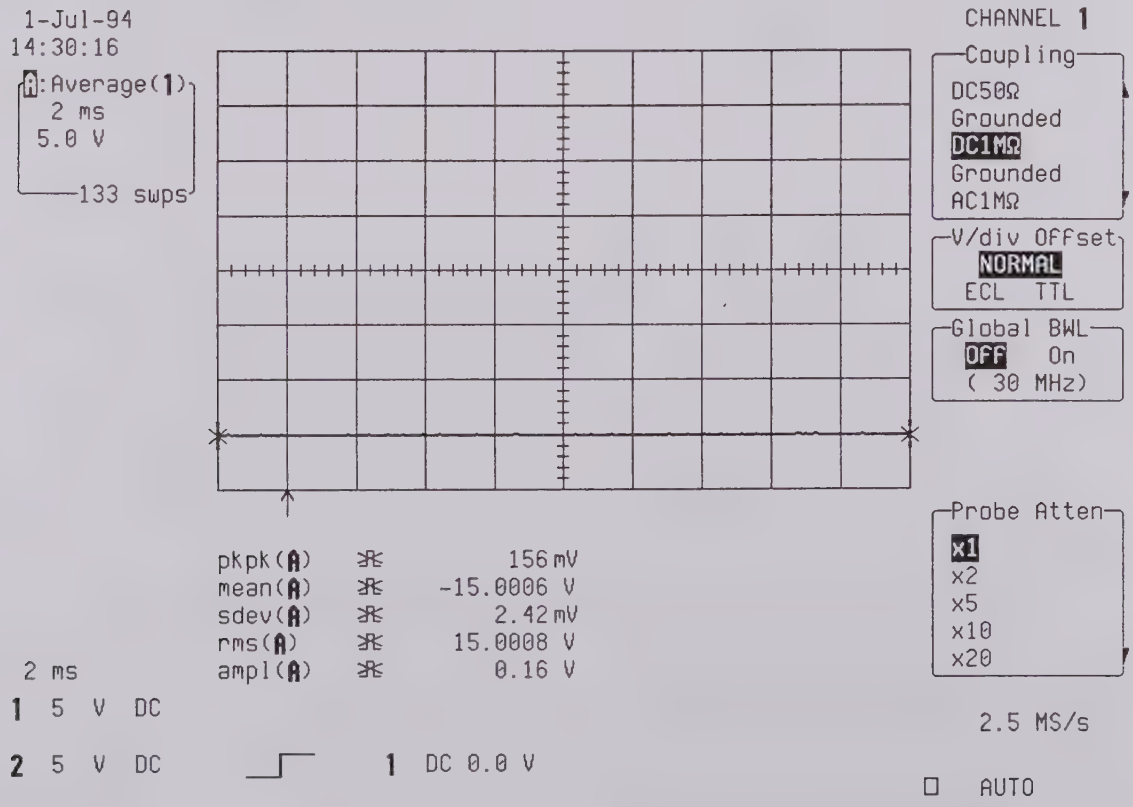
- For the low sensitivities : **2, 5, 10, 20** and **50 mV/div.**, use a **1MΩ 20 dB** attenuator (1/10), see table 3-4.

Range	Attenuator	Conditions of Test			Average Mean Parameter Reading		
Volt/div Control	20 dB	PS Output	9350/M/L Input	9350/M/L Full scale	Min Value ±X% of FS	Max Value ±X% of FS	± X%
2 mV	Yes	± 60 mV	± 6 mV	16 mV	± 5.2 mV	± 6.8 mV	5%
5 mV	Yes	± 150 mV	± 15 mV	40 mV	± 13.8 mV	± 16.2 mV	3%
10 mV	Yes	± 300 mV	± 30 mV	80 mV	± 28.4 mV	± 31.6 mV	2%
20 mV	Yes	± 600 mV	± 60 mV	160 mV	± 56.8 mV	± 63.2 mV	2%
50 mV	Yes	± 1.5 V	±150 mV	400 mV	± 142 mV	± 158 mV	2%
.1 V	No	± 300 mV	± 300 mV	800 mV	± 284 mV	± 316 mV	2%
.2 V	No	± 600 mV	± 600 mV	1.6 v	± 568 mV	± 632 mV	2%
.5 V	No	± 1.5 V	± 1.5 V	4 V	± 1.42 V	± 1.58 V	2%
1 V	No	± 3 V	± 3 V	8 V	± 2.84 V	± 3.16 V	2%
2 V	No	± 6 V	± 6 V	16 V	± 5.68 V	± 6.32 V	2%
5 V	No	± 15 V	± 15 V	40 V	± 14.2 V	± 15.8 V	2%

Table 3-4 : 1MΩ DC Linearity Readout Accuracy

- For each point, read off the **Mean** parameter voltage, and compare it to the digital readout of the voltage reference.
- The **mean** parameter reading should be within the limits shown in table 3-4.
- Repeat steps 3.7.1.a and 3.7.1.b for Channel 2 substituting channel controls and input connector.


1-Jul-94
14:31:14
A:Average(1)
2 ms
1.00 V
124 swps
CHANNEL 1
Coupling
DC50Ω
Grounded
DC1MΩ
Grounded
AC1MΩ
V/div Offset
NORMAL
ECL TTL
Global BWL
OFF On
(30 MHz)
Probe Atten
x1
x2
x5
x10
x20
pkpk(A) 31.2 mV
mean(A) 3.03259 V
sdev(A) 3.301 mV
rms(A) 3.03255 V
ampl(A) 31 mV
2 ms
1 1 V DC
2 1 V DC
1 DC 0.00 V
2.5 MS/s
AUTO


1-Jul-94
14:30:16
A:Average(1)
2 ms
5.0 V
133 swps
CHANNEL 1
Coupling
DC50Ω
Grounded
DC1MΩ
Grounded
AC1MΩ
V/div Offset
NORMAL
ECL TTL
Global BWL
OFF On
(30 MHz)
Probe Atten
x1
x2
x5
x10
x20
pkpk(A) 156 mV
mean(A) -15.0006 V
sdev(A) 2.42 mV
rms(A) 15.0008 V
ampl(A) 0.16 V
2 ms
1 5 V DC
2 5 V DC
1 DC 0.0 V
2.5 MS/s
AUTO

3.8 Offset

3.8.1 Description

The maximum allowed offsets depend on the sensitivity as shown in table 3-5 and 3-6, and is tested at DC 1 MΩ, over the full 2 mV to 5 V range.

Specifications

± 120mV: for the ranges 2mV/div., 5 mV/div.
± 1.2 V : for 10 mV/div., 20 mV/div., 50 mV/div., 100 mV/div.
± 24 V : for 200 mV/div., 500 mV/div., 1 V/div., 2 V/div., 5 V/div.

3.8.1.a Negative Offset Control Procedure

Set the DSO as follows :

- Turn on trace : **Channel 1**
- Display setup : **Standard, Persistence off, Dot join on, Single grid**
- Input Coupling : **DC 1MΩ**
- V/div. offset : **Normal**
- Global BWL : **Off**
- Probe atten : **X1**
- Input gain : **5 mV**
- Trigger setup : **Edge**
- Trigger on : **1**
- Coupling 1 : **DC**
- Slope 1 : **Pos**
- Mode : **Auto**
- Holdoff : **Off**
- Timebase : **2 msec/div.**
- Channel use : **2**
- Record up : **50 K**
- Turn on trace : **A**
- Select Math Setup
- For Math : **Use at most 5000 points**
- Redefine A
- Use Math ? : **Yes**
- Math Type : **Average**
- Avg Type : **Summed**
- For : **1000 sweeps**
- Of : **Channel 1**

- Turn off trace : **Channel 1**
- Cursors/Measure : **Parameters**
- Mode : **Std Voltage**
- Statistics : **off**
- On displayed trace : **A**

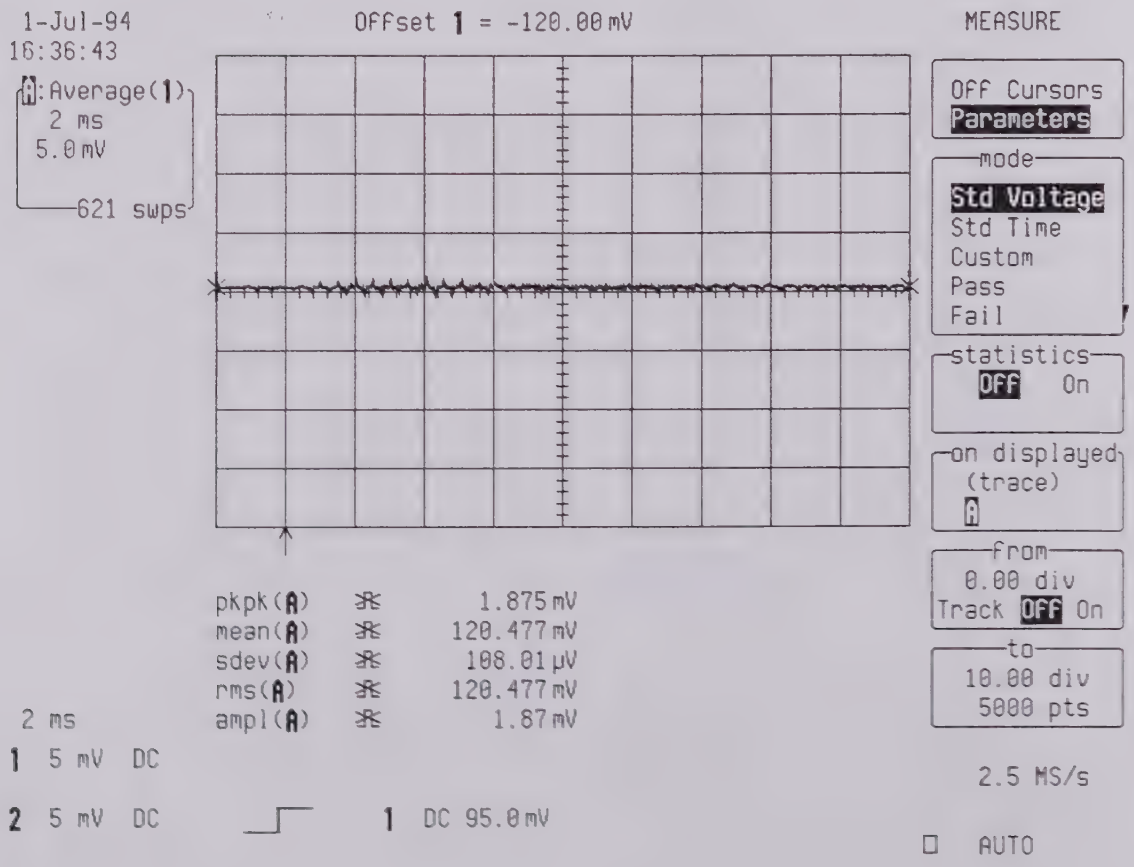
- From the high precision voltage source PS5004, apply to Channel 1 **+ 120 mV** .
- Using the offset control, move Channel 1 trace through the entire range until the maximum offset value is reached : **- 120 mV**.

- Verify that the displayed trace A : Average (1) is in the screen, near to the center horizontal graticule line.

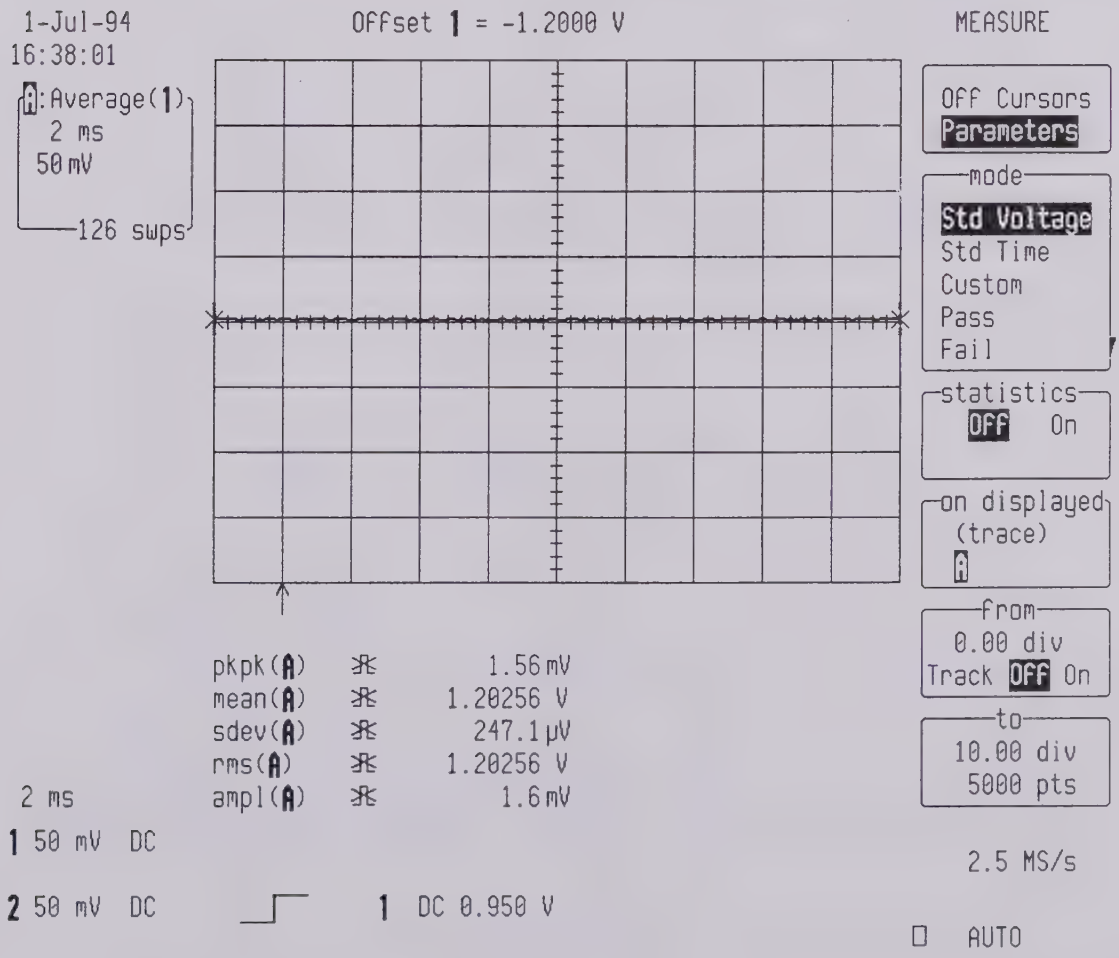
- Press clear sweeps.
- Check after at least 100 sweeps that the mean (A) parameter readout is : **+ 120 mV ± 3 %**.

Range	Conditions of Test		Offset Control	Mean Parameter Reading		
Volts/div Control	PS Output	9350/M/L Input	9350/M/L Offset	Minimum value, -X %	Maximum Value, +X %	
5 mV	+ 120 m V	+ 120 mV	- 120 mV	+ 116.4 mV	+ 123.6 mV	3%
50 mV	+ 1.2 V	+ 1.2 V	- 1.2 V	+ 1.164 V	+ 1.236 V	3%
5 V	+ 20 V	+ 20 V	- 24 V	+ 18.6 V	+ 21.4V	7%

Table 3-5 : Negative offset control



- Set input gain to **50 mV/div.**, from the high precision voltage source, apply to Channel 1 the following voltage value : **+ 1.2 V.**
- Using the offset control, move the Ch1 trace through the entire range until the following offset value is reached : **- 1.2 V.**
- Verify that the displayed trace A : Average (1) is in the screen (near to the center horizontal graticule line) .
- Press clear sweeps
- Check after at least 100 sweeps that the mean (A) parameter readout is : **+ 1.2 V ± 3 %** (see table 3-5).



- Set input gain to **5 V/div.**, from the high precision voltage source, apply to Channel 1 : **+ 20 V** (maximum from PS5004).
- Using the offset control, move the Ch1 trace through the entire range until the maximum offset value is reached : **- 24 V**.
- Verify that the displayed trace A : Average (1) is in the screen
- Press clear sweeps
- Check after at least 100 sweeps that the mean (A) parameter readout is : **+ 20 V ± 7 %** (see table 3-5).
- Repeat step 3.8.1.a for Channel 2 substituting channel control and input connector.

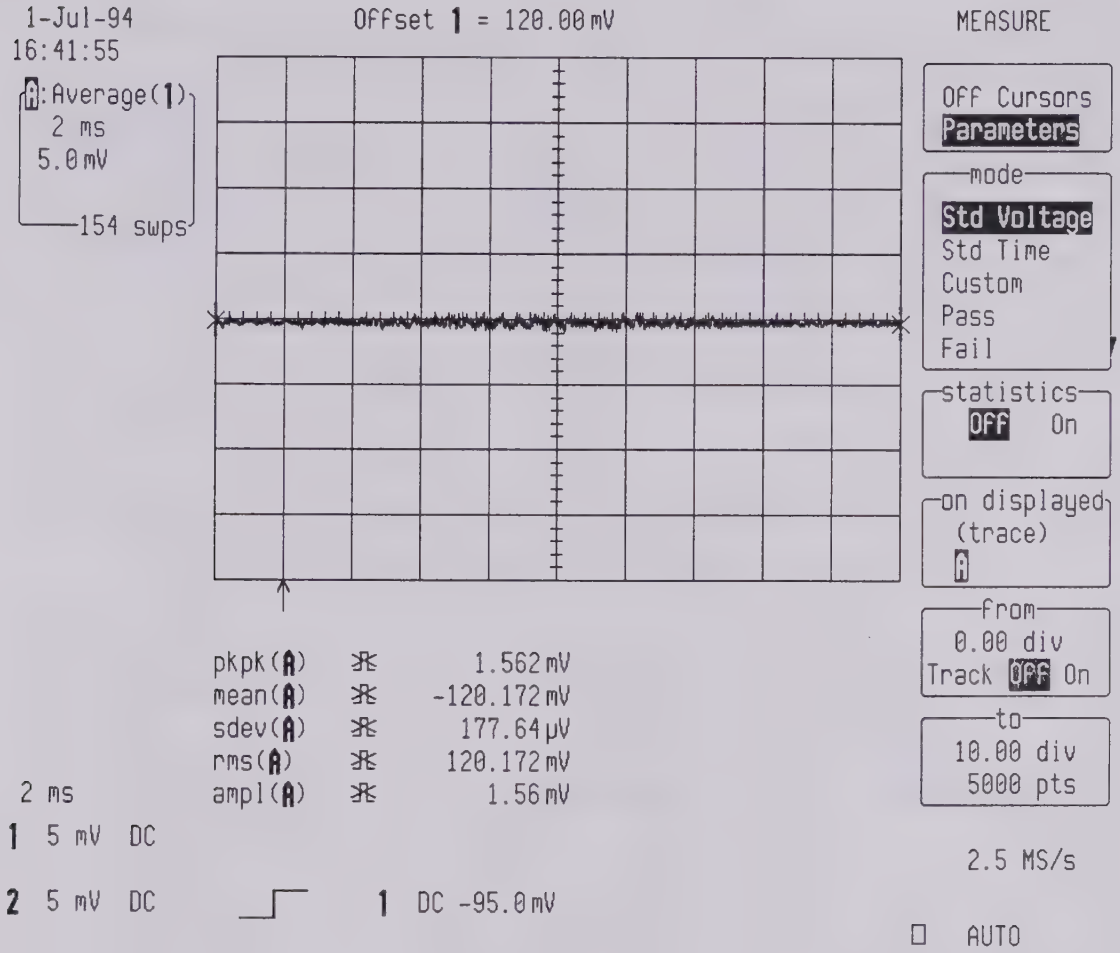
3.8.1.b Positive Offset Control Procedure

Set the DSO as in 3.8.1.a:

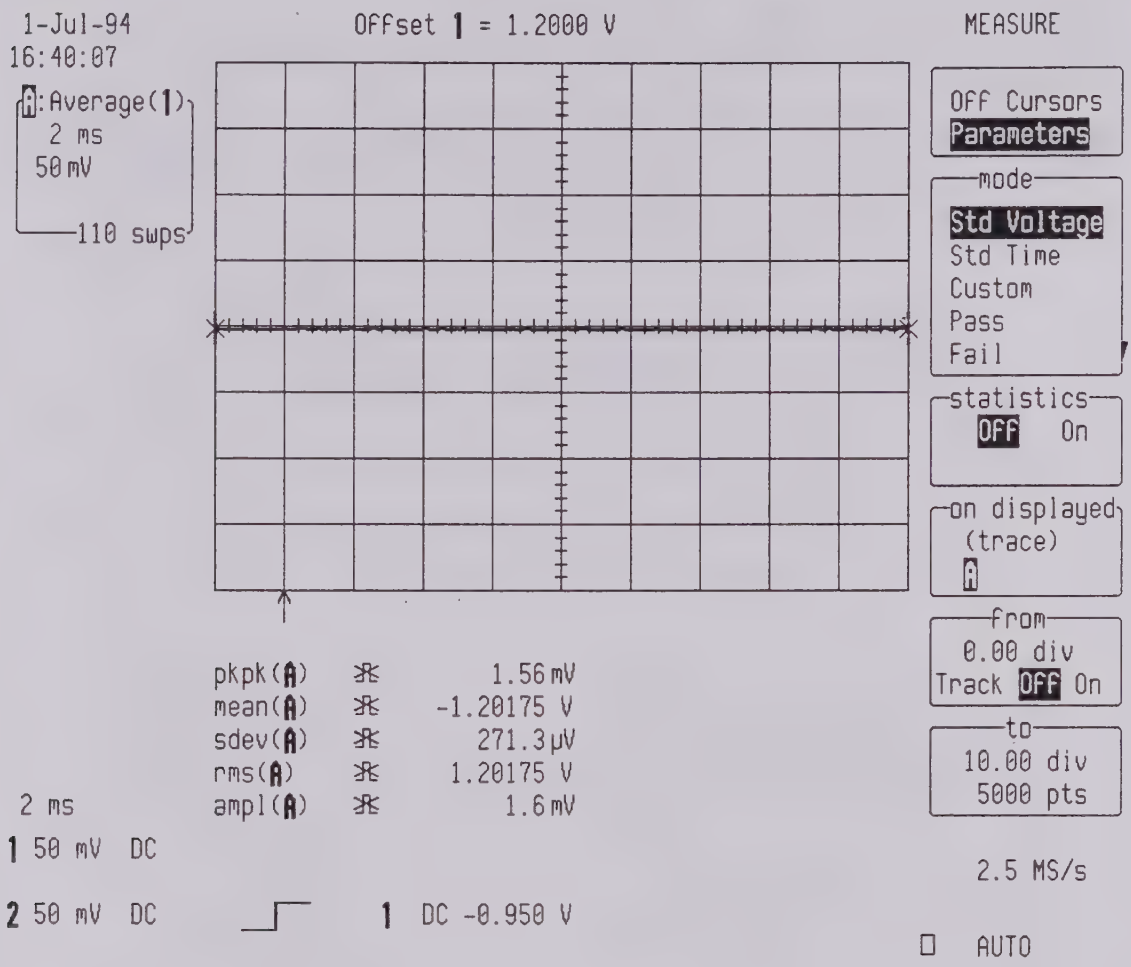
- Channel 1 input gain : **5 mV**
- From the high precision voltage source PS5004, apply to Channel 1 : **- 120 mV** .
- Using the offset control, move Channel 1 trace through the entire range until the maximum offset value is reached : **+ 120 mV**.
- Verify that the displayed trace A : Average (1) is in the screen, near to the center horizontal graticule line.
- Press clear sweeps.
- Check after at least 100 sweeps that the mean (A) parameter readout is : **- 120 mV ± 3 %**.

Range	Conditions of Test		Offset Control	Mean Parameter Reading		
Volts/div Control	PS Output	9350/M/L Input	9350/M/L Offset	Minimum value, -X %	Maximum Value, +X %	
5 mV	- 120 mV	- 120 mV	+ 120 mV	- 116.4 mV	- 123.6 mV	3%
50 mV	- 1.2 V	- 1.2 V	+ 1.2 V	- 1.164 V	- 1.236 V	3%
5 V	- 20 V	- 20 V	+ 24 V	- 18.6 V	- 21.4V	7%

Table 3-6 : Positive offset control



- Set input gain to **50 mV/div.**, from the high precision voltage source, apply to Channel 1 the following voltage value : **+ 1.2 V**.
- Using the offset control, move the Ch1 trace through the entire range until the following offset value is reached : **- 1.2 V**.
- Verify that the displayed trace A : Average (1) is in the screen (near to the center horizontal graticule line) .
- Press clear sweeps
- Check after at least 100 sweeps that the mean (A) parameter readout is : **+ 1.2 V ±3 %** (see table 3-6).



- Set input gain to **5 V/div.**, from the high precision voltage source, apply to Channel 1 - **20 V** (maximum from PS5004).
- Using the offset control, move the Ch1 trace through the entire range until the maximum offset value is reached : + **24 V**.
- Verify that the displayed trace A : Average (1) is in the screen.
- Press clear sweeps
- Check after at least 100 sweeps that the mean (A) parameter readout is : - **20 V** ± **7 %** (see table 3-6).
- Repeat step 3.8.1.b for Channel 2 substituting channel control and input connector.

3.9 Bandwidth

3.9.1 Description

The purpose of this test is to ensure that the entire system has a bandwidth of at least 500 MHz at 200 mV/div. An external source is used as the reference to provide a signal where amplitude and frequency are well controlled. A serious measurement of the bandwidth requires the use of a source whose amplitude does not change with frequency. The LeCroy calibration software corrects for the measured amplitude variation of the generator used. Generators can have errors of - 2 dB above 500 MHz. The non flatness of the generator should be taken into consideration.

Specifications

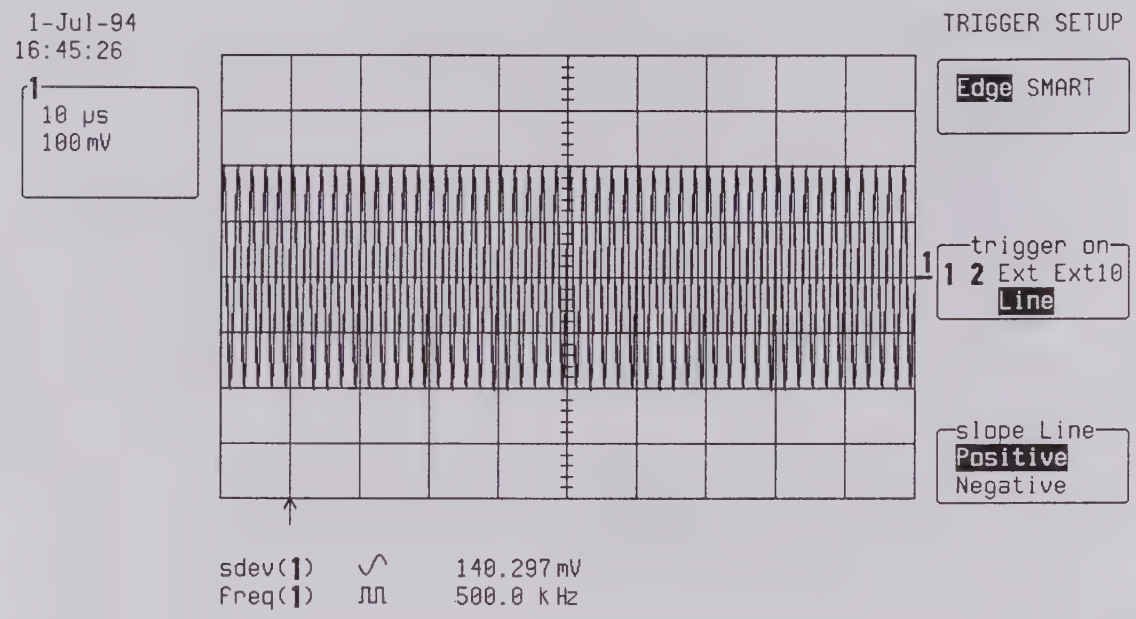
DC to at least 500 MHz (- 3 dB) at 200 mV/div. and above.
DC to at least 400 MHz below 200 mV/div.
DC to at least 350 MHz at 2 mV/div.

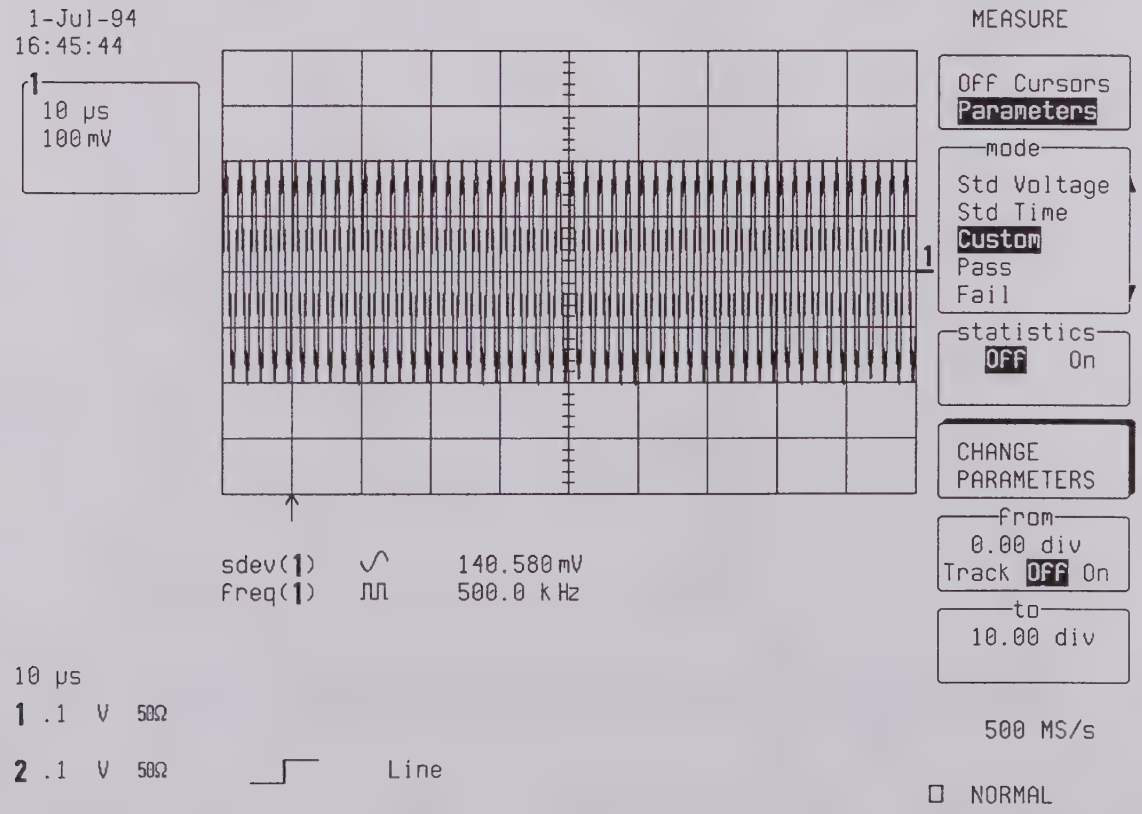
3.9.1.a DC 50 Ω

Procedure

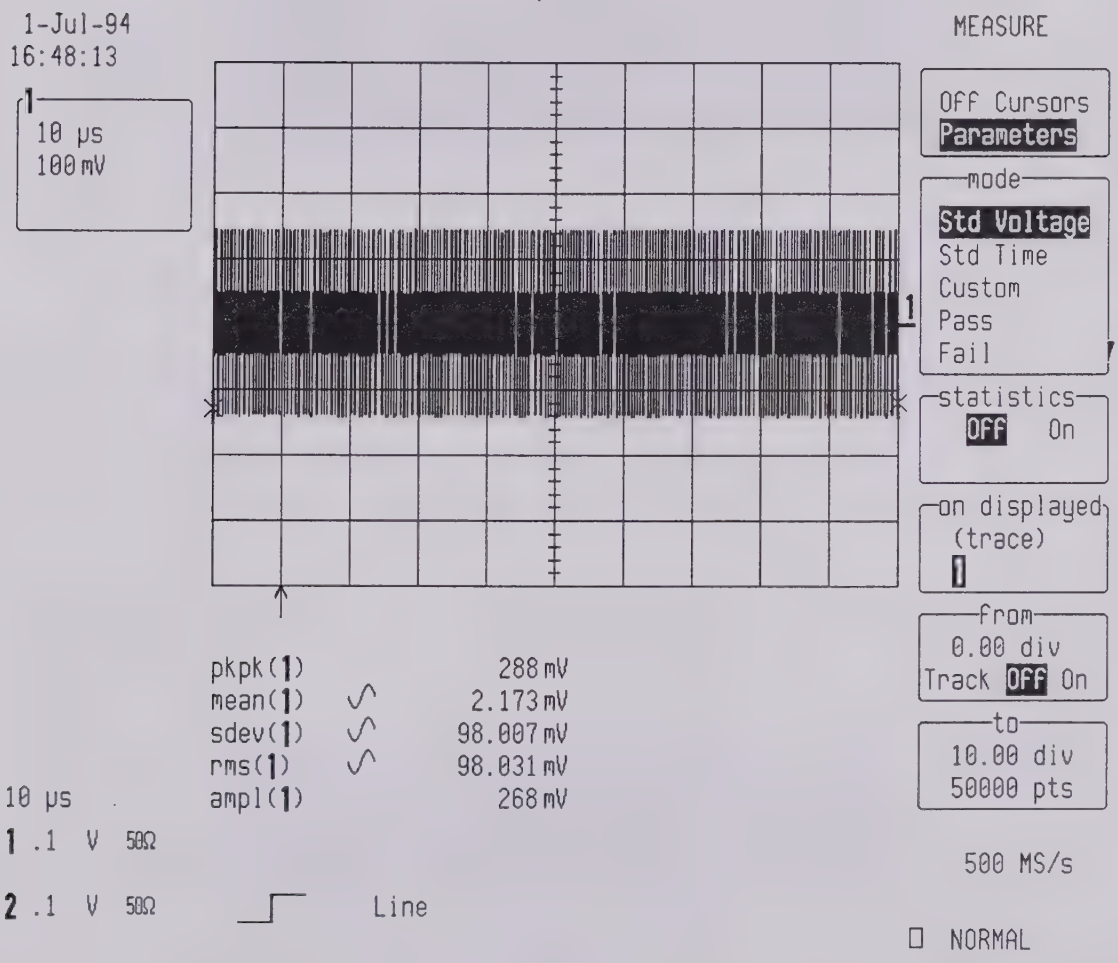
- Turn on trace : **Ch1**
- Display setup : **Standard, Persistence off, Dot join on, Single grid**
- Input Coupling : **DC 50 Ω**
- V/div. offset : **Normal**
- Global BWL : **Off**
- Probe atten : **X1**
- Input gain : **100 mV/div.**
- Offset : **0 mV**
- Trigger setup : **Edge**
- Trigger on : **Line**
- Slope Line : **Pos**
- Mode : **Norm**
- Timebase : **10 µsec/div.**
- Channel use : **2**
- Record up : **50 K**
- Press Cursors/Measure: **Parameters**
- Mode : **Custom**
- Statistics : **off**
- Change parameters : **Measure**
- On line 1 : **sdev of 1**
- On line 2 : **freq of 1**

- Connect a leveled sine wave generator to Channel 1 (i.e. Marconi 2030), set the frequency to **500 KHz**, adjust the generator output amplitude to get on DSO : **sdev(1) = 140 mV**.

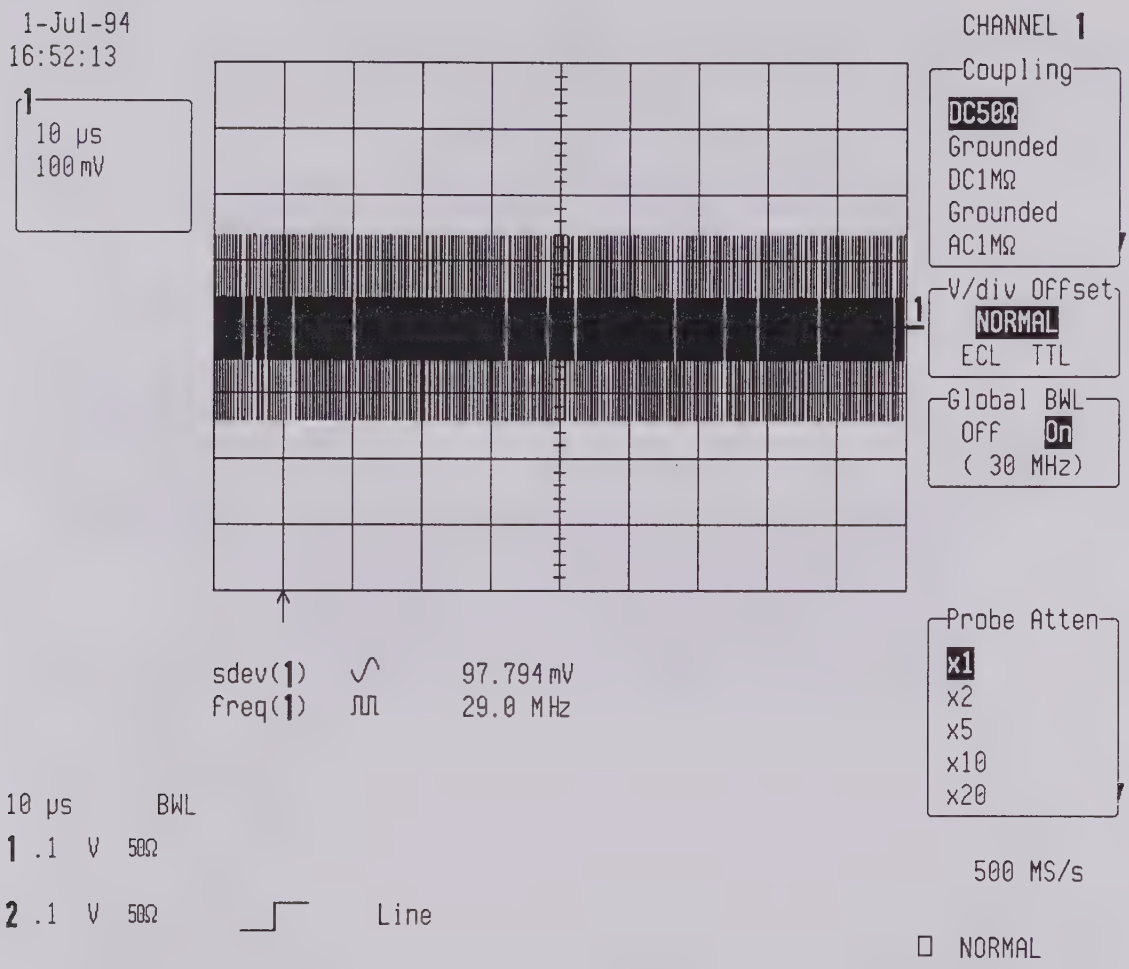

1-Jul-94
16:45:26
1
10 µs
100 mV
TRIGGER SETUP
Edge SMART
trigger on
1 2 Ext Ext10
Line
slope Line
Positive
Negative
sdev(1) 140.297 mV
Freq(1) 500.0 kHz
10 µs
1 .1 V 50Ω
2 .1 V 50Ω
Line
500 MS/s
NORMAL


1-Jul-94
16:45:44
1
10 µs
100 mV
MEASURE
Off Cursors
Parameters
mode
Std Voltage
Std Time
Custom
Pass
Fail
statistics
Off On
CHANGE
PARAMETERS
from
0.00 div
Track Off On
to
10.00 div
sdev(1) 140.580 mV
Freq(1) 500.0 kHz
10 µs
1 .1 V 50Ω
2 .1 V 50Ω
Line
500 MS/s
NORMAL

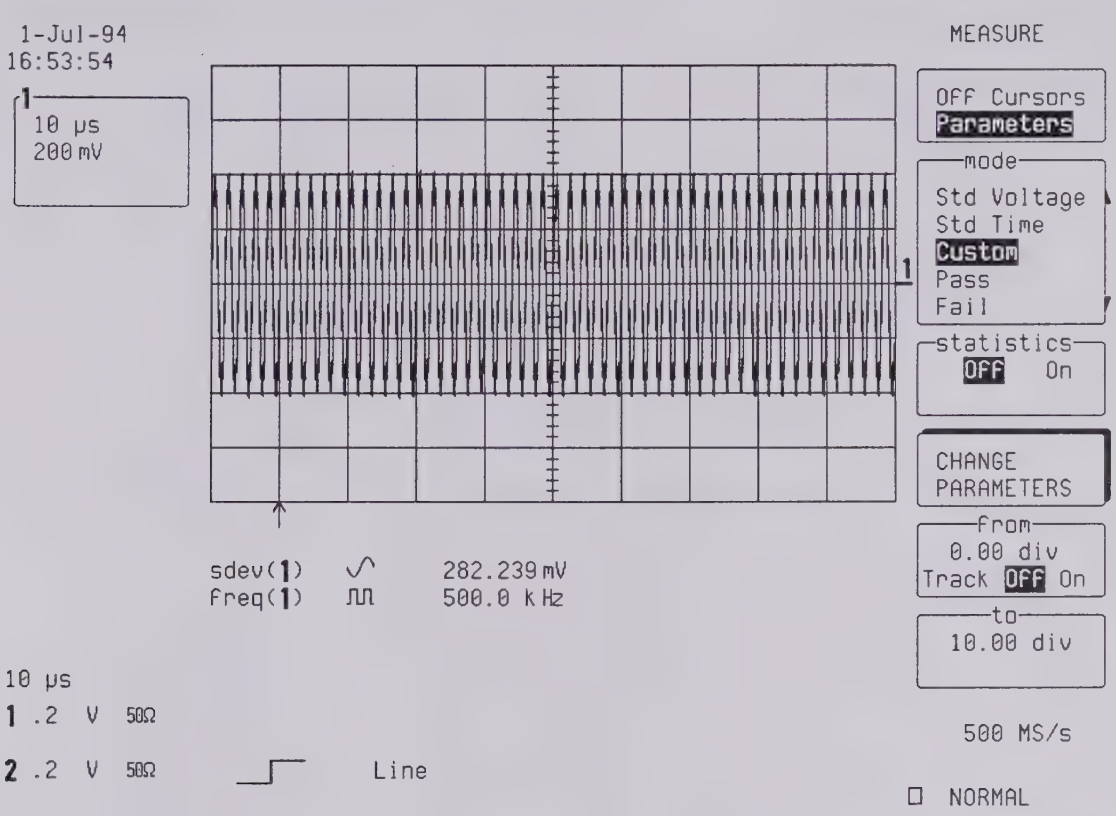
- Increase the generator frequency in multi **50 MHz** steps until the sine wave amplitude is 70% of the initial amplitude at 500 KHz .
- At each 50 MHz step, check that **sdev(1) > 98 mV**
- When **sdev(1) = 98 mV (3 dB point)** the frequency of the generator must be at least **400 MHz**.

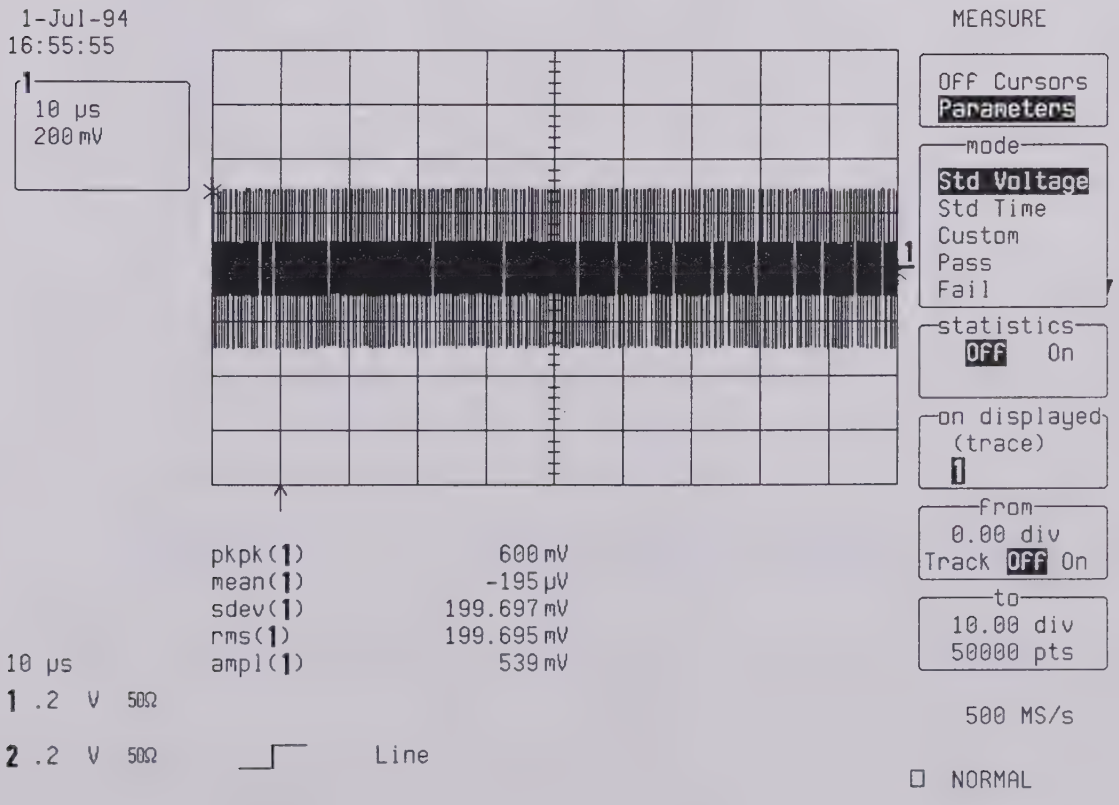


- Select Coupling and **Global BWL : On** (bandwidth limiter on)
- Check that the frequency at the 3 dB point (**sdev(1) = 98 mV**) is typically **30 MHz** . (between 22 MHz and 43 MHz).



- Set DSO Input gain : **200 mV/div.**
- Set sine wave generator frequency to **500 KHz**, adjust the generator output amplitude to get on DSO : **sdev(1) = 282 mV**.
- Increase the generator frequency in multi **50 MHz** steps until the sine wave amplitude is 70% of the initial amplitude at 500 KHz .
- At each 50 MHz step, check that **sdev(1) > 198 mV**
- When **sdev(1) = 198 mV (3 dB point)** the frequency of the generator must be at least **500 MHz**.

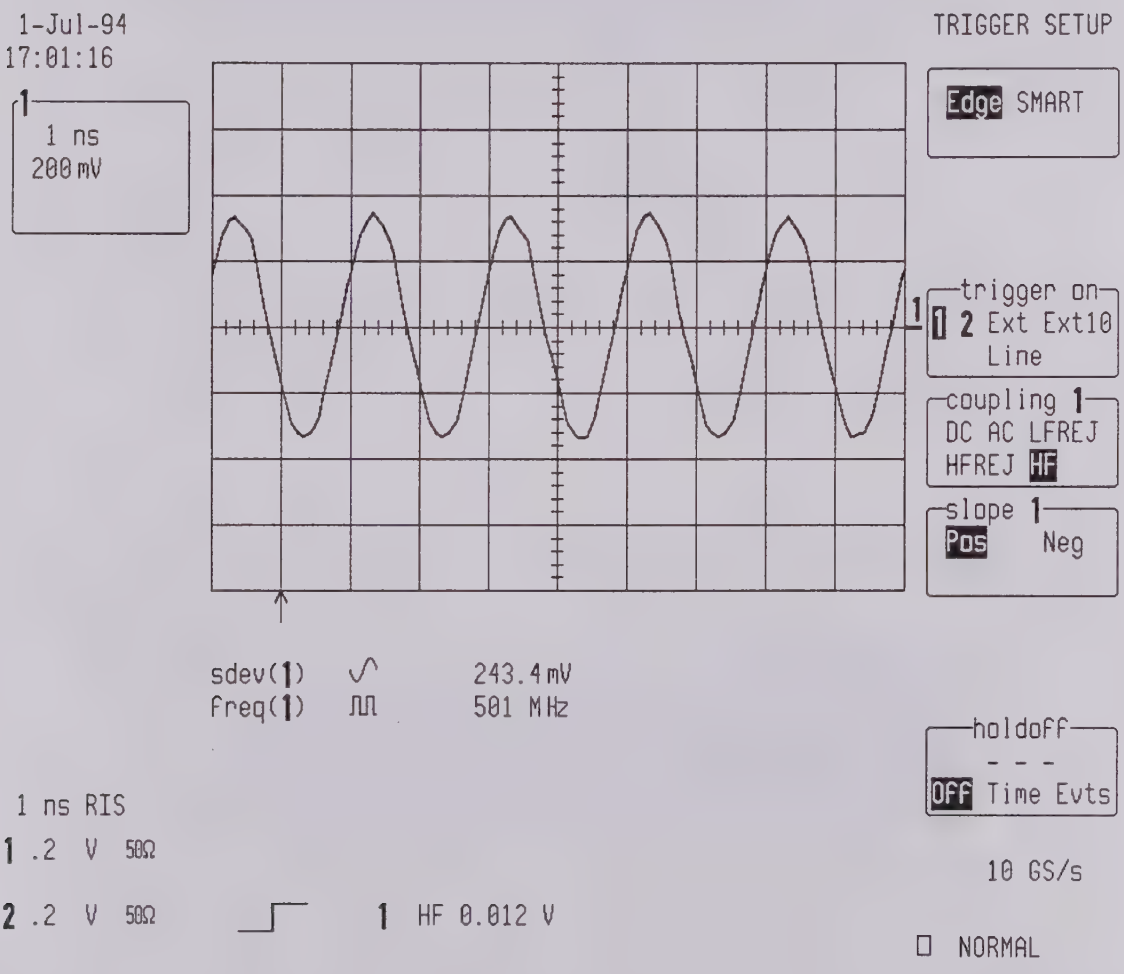

1-Jul-94
16:53:54
1
10 µs
200 mV
MEASURE
Off Cursors
Parameters
mode
Std Voltage
Std Time
Custom
Pass
Fail
statistics
Off On
CHANGE
PARAMETERS
from
0.00 div
Track Off On
to
10.00 div
sdev(1) 282.239 mV
freq(1) 500.0 kHz
10 µs
1 .2 V 50Ω
2 .2 V 50Ω
Line
500 MS/s
NORMAL


1-Jul-94
16:55:55
1
10 µs
200 mV
MEASURE
Off Cursors
Parameters
mode
Std Voltage
Std Time
Custom
Pass
Fail
statistics
Off On
on displayed
(trace)
1
from
0.00 div
Track Off On
to
10.00 div
50000 pts
pkpk(1) 600 mV
mean(1) -195 µV
sdev(1) 199.697 mV
rms(1) 199.695 mV
ampl(1) 539 mV
10 µs
1 .2 V 50Ω
2 .2 V 50Ω
Line
500 MS/s
NORMAL

3.9.1.a.1 Trigger Bandwidth

- Set Trigger on : **1**
- Coupling 1 : **HF**
- Slope 1 : **Pos**
- Mode : **Norm**
- Timebase : **1 nsec/div.**

- Set sine wave generator frequency to **501 MHz**
- Change Trigger level, until the scope triggers on Channel 1.



- Check : The scope must keep triggering in a stable way, a smooth 501 MHz sine wave must be visible on the screen.

- Repeat step 3.9.1.a and 3.9.1.a.1 for Channel 2 substituting channel control and input connector.

3.9.1.b DC 1 MΩ

The purpose of this test is to ensure that the entire 9350/M/L system has a bandwidth of at least **250 MHz at probe tip**.
Set up a Tektronix SG503 leveled sine wave generator or equivalent.

- Terminate the output of the SG503 via a **50Ω feed through** and connect it to the channel 1 input through a **10X-probe** using a probe tip BNC Jack adapter.
  Make sure the probe compensation is perfectly adjusted at low frequency.

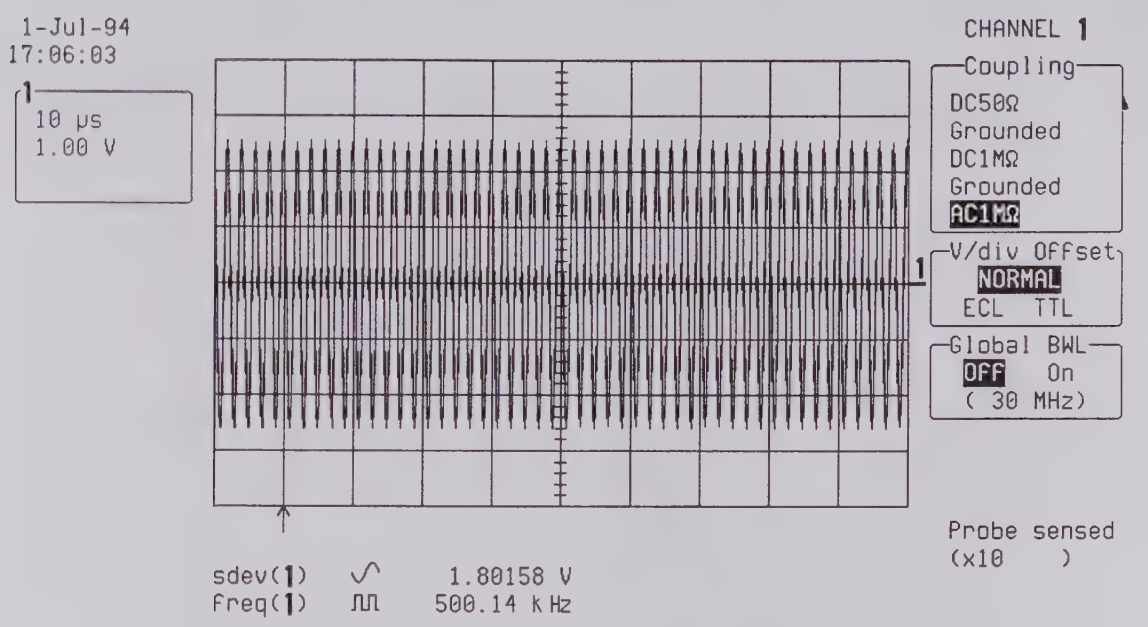
- Turn on trace : **Ch1**
- Display setup : **Standard, Persistence off, Dot join on, Single grid**
- Input Coupling : **AC 1MΩ**
- V/div. offset : **Normal**
- Global BWL : **Off**
- Probe atten : **X10**
- Input gain : **1 V/div.**
- Offset : **0 mV**
- Trigger setup : **Edge**
- Trigger on : **Line**
- Slope Line : **Pos**
- Mode : **Norm**
- Timebase : **10 µsec/div.**
- Channel use : **2**
- Record up : **50 K**
- Press Cursors/Measure: **Parameters**
- Mode : **Custom**
- Statistics : **off**
- Change parameters : **Measure**
- On line 1 : **sdev of 1**
- On line 2 : **freq of 1**

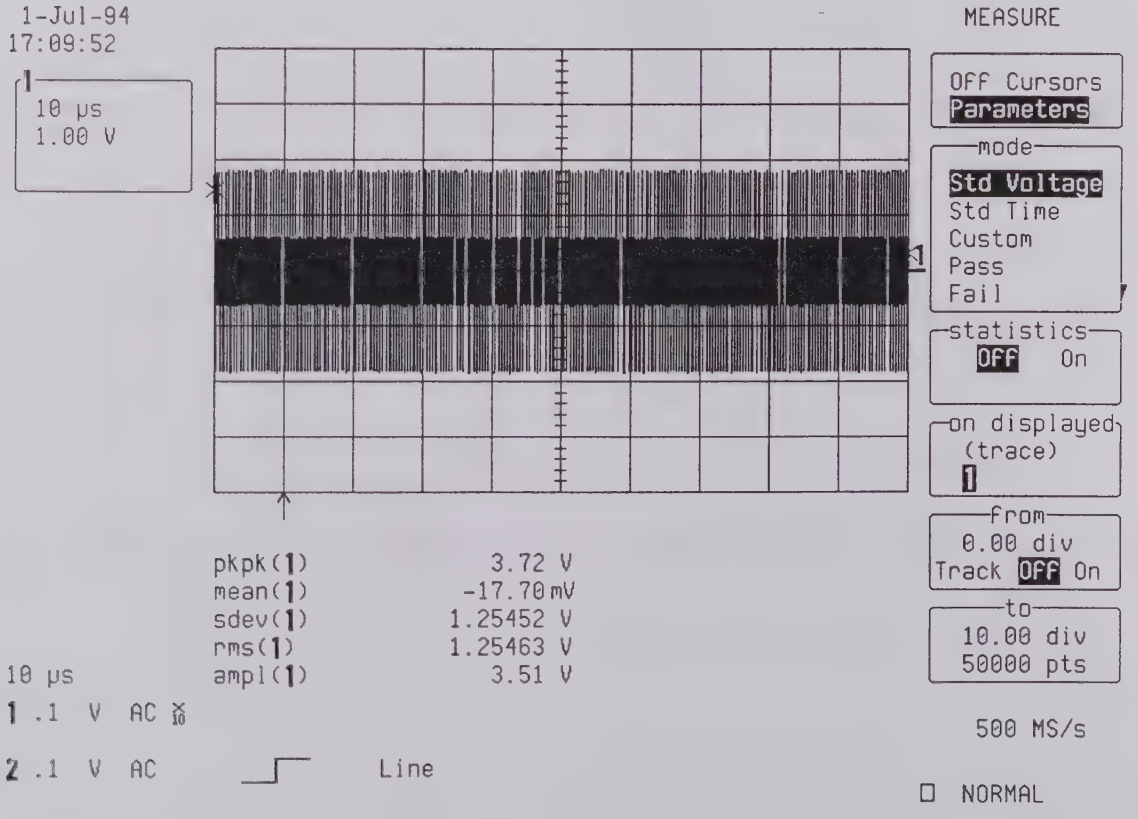
- Set sine wave generator frequency to **500 KHz**, adjust the generator output amplitude to get on DSO : **sdev(1) = 1.8 V**.

- Increase the generator frequency in multi **MHz** steps until the sine wave amplitude is 70% of the initial amplitude at 500 KHz .

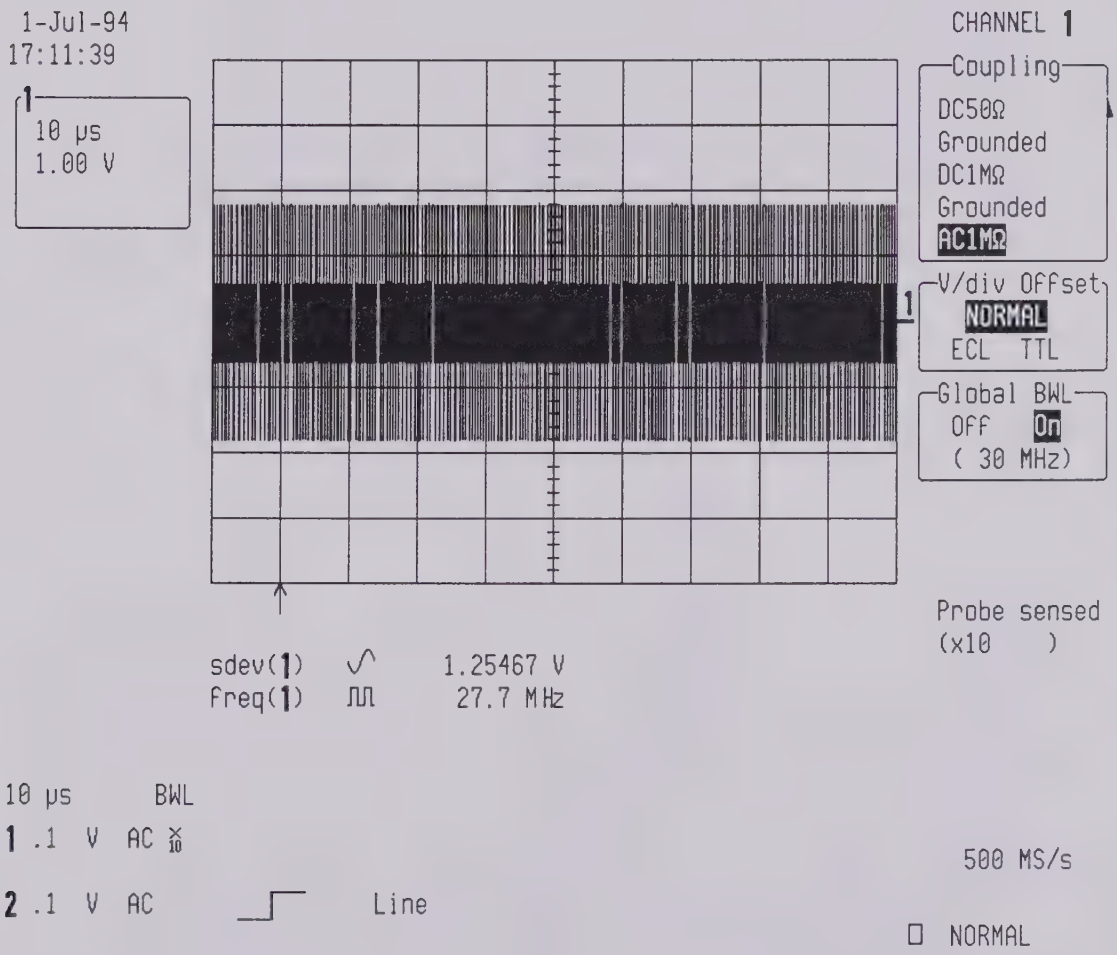
- At each frequency step, check that **sdev(1) > 1.25 V**

- When **sdev(1) = 1.25 V (3 dB point)** the frequency of the generator must be at least **250 MHz**.


1-Jul-94
17:06:03
10 µs
1.00 V
CHANNEL 1
Coupling
DC50Ω
Grounded
DC1MΩ
Grounded
AC1MΩ
V/div Offset
NORMAL
ECL TTL
Global BWL
OFF On
(30 MHz)
Probe sensed
(x10)
sdev(1) 1.80158 V
Freq(1) 500.14 kHz
10 µs
1 .1 V AC
2 .1 V AC
Line
500 MS/s
NORMAL


1-Jul-94
17:09:52
10 µs
1.00 V
MEASURE
Off Cursors
Parameters
mode
Std Voltage
Std Time
Custom
Pass
Fail
statistics
OFF On
on displayed
(trace)
1
from
0.00 div
Track OFF On
to
10.00 div
50000 pts
pkpk(1) 3.72 V
mean(1) -17.70 mV
sdev(1) 1.25452 V
rms(1) 1.25463 V
ampl(1) 3.51 V
10 µs
1 .1 V AC
2 .1 V AC
Line
500 MS/s
NORMAL

- Set the bandwidth limiter on :
- Select Coupling and **Global BWL : On**
- Check that the frequency at the 3 dB point is typically **30 MHz** .
  (between 22 MHz and 43 MHz).



- Repeat step 3.9.1.b for Channel 2 substituting channel control and input connector.

3.10 Trigger Level

3.10.1 Description

The trigger capabilities are tested for several cases of the standard edge trigger :

- Channel (internal), and External Trigger sources
- Three DC levels : - 3, 0, - 3 major screen divisions
- DC coupling
- Positive and negative slopes

3.10.2 Channel (internal)

The horizontal and vertical errors for a trigger at 0 v threshold are determined by comparing the crossing point of the same sine wave at two different amplitudes.

- Setup any sine wave generator capable of generating sine waves of **1 KHz**, 4 V pkpk.
- Connect the generator output to Channel 1

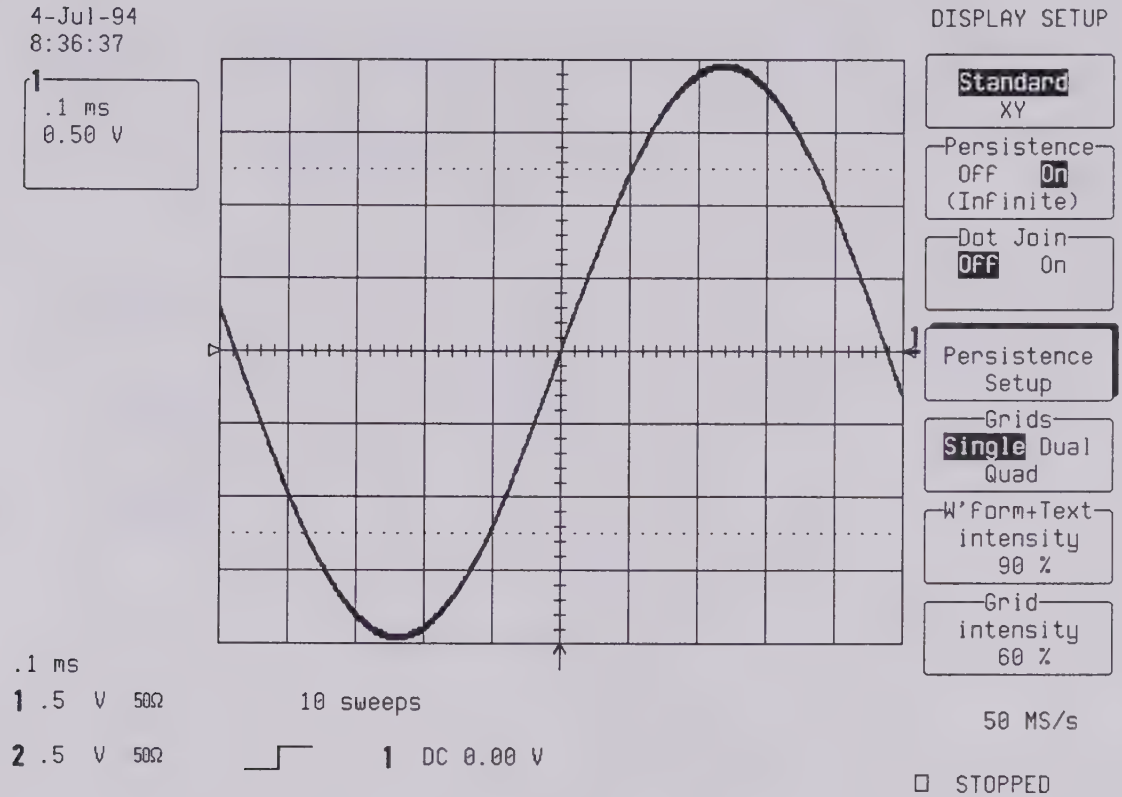
- Turn on trace : **Ch1**
- Input Coupling Ch 1 : **DC 50 Ω**
- V/div. offset : **Normal**
- Input gain : **.5 V/div.**
- Input offset : **0 mV**
- Trigger setup : **Edge**
- Trigger on : **1**
- Coupling 1 : **DC**
- Slope 1 : **Pos**
- Set Trigger level : **DC 0.0 mV**
- Mode : **Single**
- Pre-Trigger Delay : **50 %**
- Timebase : **.1 msec/div.**
- Channel Use : **2**
- Record up to : **50 K samples**

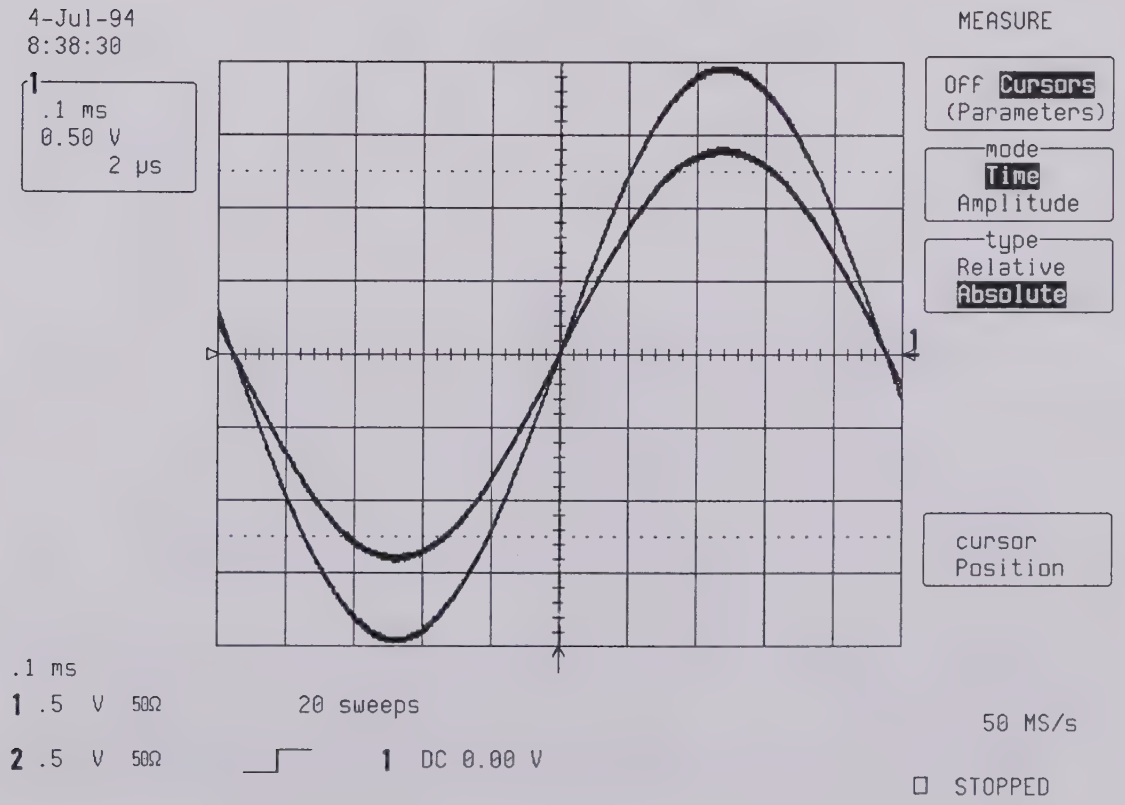
- Adjust the sine wave generator's output amplitude to get **8 divisions peak to peak**, corresponding to a **4 V** amplitude.
- It is important that the offset of the input is set to **zero mV**, use show status and acquisition status to verify.

- Display setup : **Dot join Off**
- Set **Persistence On,** and acquire few sweeps in Single Trigger mode.
- Connect a **3 dB attenuator**, and acquire few more sweeps in Single mode.

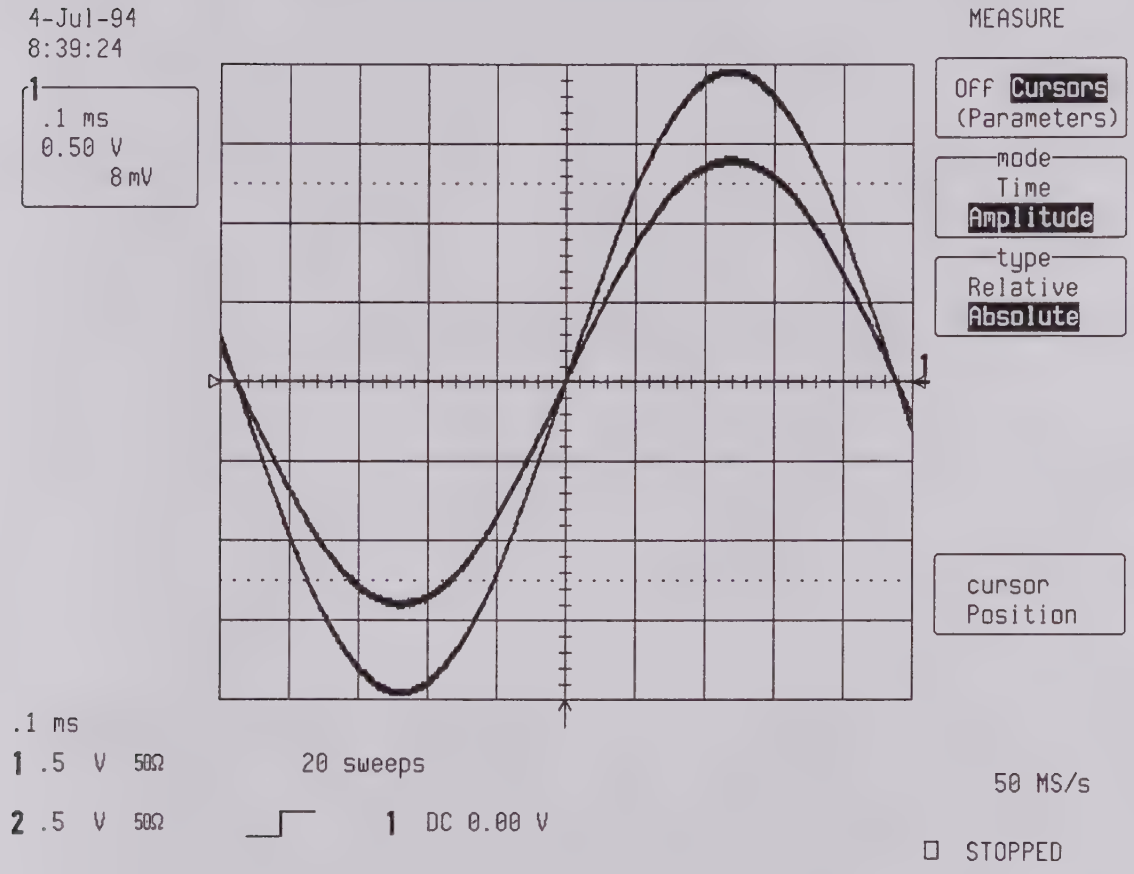
- Select Cursors/Measure : **Cursors, Time, Absolute**
- Use the " cursor position " knob, to move the marker at the **horizontal crossing point** of the two sine waves.

- Check that the **time** difference obtained between the marker and the trigger is within **± 20 μ sec.** The time readout is below 0.50 V in the icon **1,** at top left.


4-Jul-94
8:36:37
1
.1 ms
0.50 V
DISPLAY SETUP
Standard
XY
Persistence
Off On
(Infinite)
Dot Join
Off On
Persistence
Setup
Grids
Single Dual
Quad
W'form+Text
intensity
90 %
Grid
intensity
60 %
.1 ms
1 .5 V 50Ω
2 .5 V 50Ω
10 sweeps
1 DC 0.00 V
50 MS/s
STOPPED


4-Jul-94
8:38:30
1
.1 ms
0.50 V
2 µs
MEASURE
Off Cursors
(Parameters)
mode
Time
Amplitude
type
Relative
Absolute
cursor
Position
.1 ms
1 .5 V 50Ω
2 .5 V 50Ω
20 sweeps
1 DC 0.00 V
50 MS/s
STOPPED

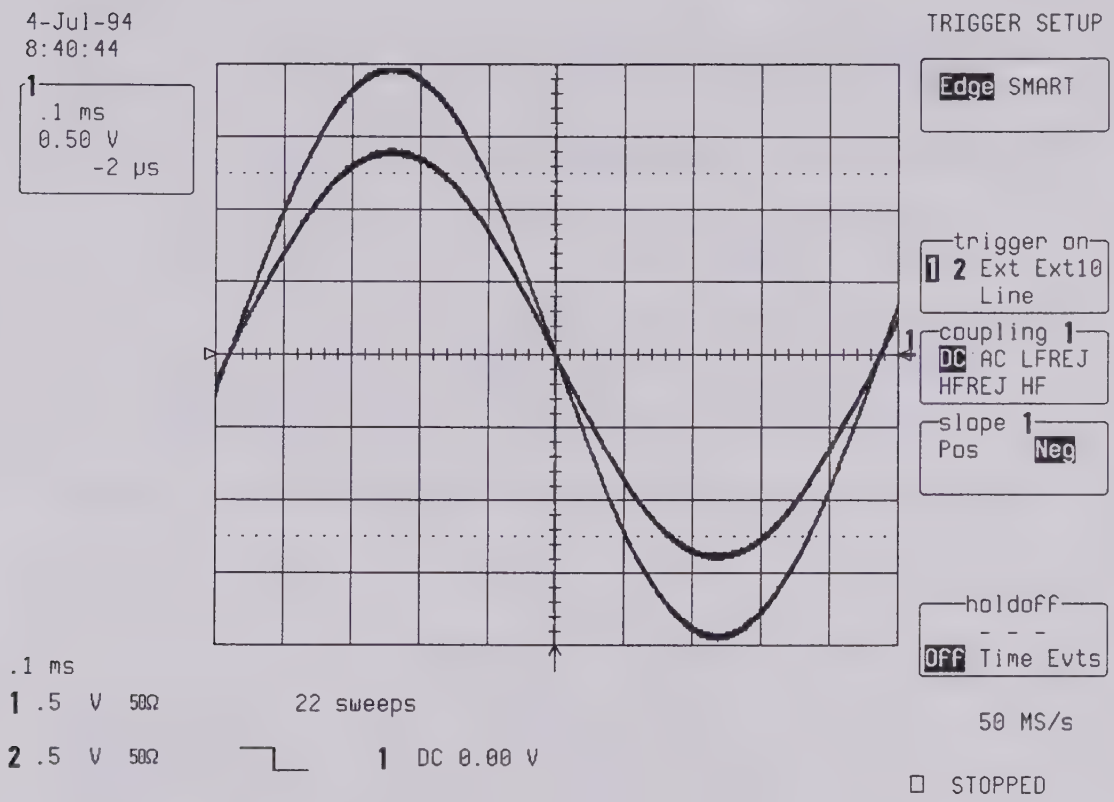
- Select Cursors mode : **Amplitude, Absolute**
- Use the " cursor position " knob, to move the marker at the **vertical crossing point** of the two sine waves.
- Check that the **voltage** difference obtained between the marker and the trigger level is within ± **200 mV.** The level readout is below 0.50 V in the icon **1,** at top left.

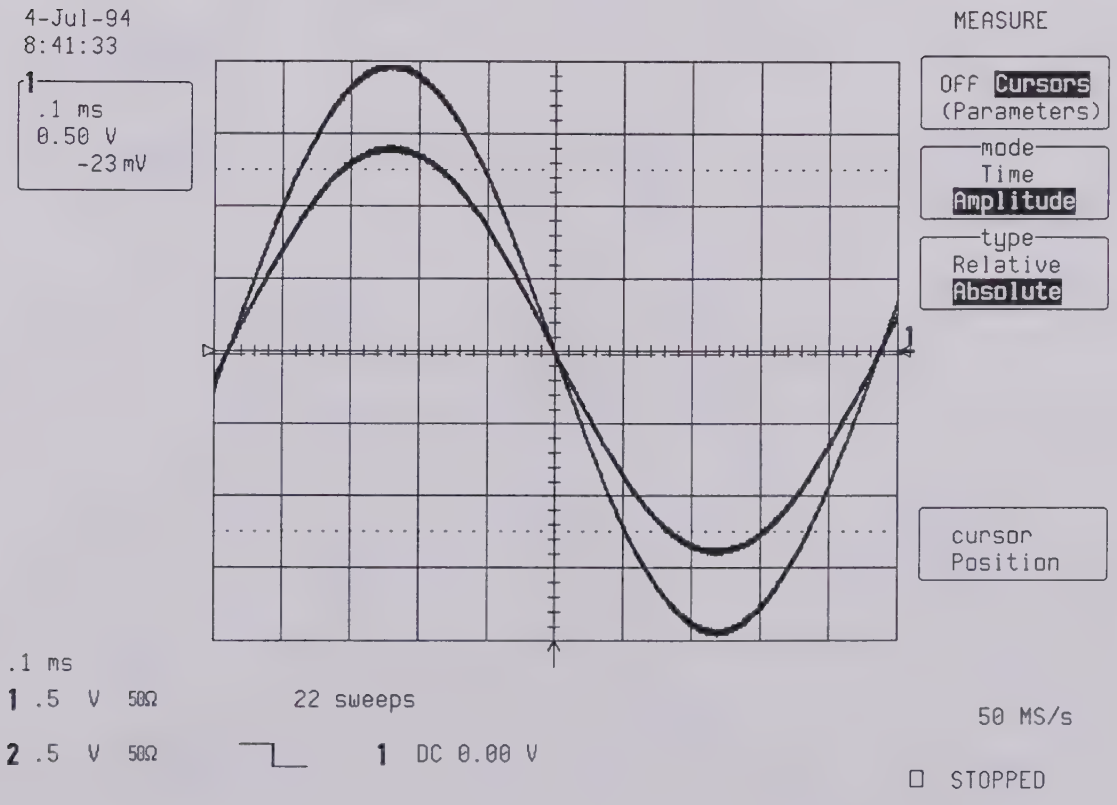


- Set Trigger Slope 1 : **Neg**

- Disconnect the **3 dB attenuator** from the BNC input
- Acquire few sweeps in Single Trigger mode.
- Connect the **3 dB attenuator**, and acquire few more sweeps in Single mode.
- Select Cursors/Measure : **Cursors, Time, Absolute**
- Use the " cursor position " knob, to move the marker at the **horizontal crossing point** of the two sine waves.
- Check that the **time** difference obtained between the marker and the trigger is within ± **20 μ sec.** The time readout is below 0.50 V in the icon **1,** at top left.

- Select Cursors mode : **Amplitude, Absolute**
- Use the " cursor position " knob, to move the marker at the **vertical crossing point** of the two sine waves.
- Check that the **voltage** difference obtained between the marker and the trigger level is within ± **200 mV.** The level readout is below 0.50 V in the icon **1,** at top left.


4-Jul-94
8:40:44
1
.1 ms
0.50 V
-2 µs
TRIGGER SETUP
Edge SMART
trigger on
1 2 Ext Ext10
Line
coupling 1
DC AC LFREJ
HFREJ HF
slope 1
Pos Neg
holdoff
- - -
Off Time Evts
.1 ms
1 .5 V 50Ω
2 .5 V 50Ω
22 sweeps
1 DC 0.00 V
50 MS/s
STOPPED


4-Jul-94
8:41:33
1
.1 ms
0.50 V
-23 mV
MEASURE
OFF Cursors
(Parameters)
mode
Time
Amplitude
type
Relative
Absolute
cursor
Position
.1 ms
1 .5 V 50Ω
2 .5 V 50Ω
22 sweeps
1 DC 0.00 V
50 MS/s
STOPPED

- Set Trigger level : **DC + 1.5 V**
- Disconnect the **3 dB attenuator** from the BNC input
- Set Trigger Slope 1 : **Pos**

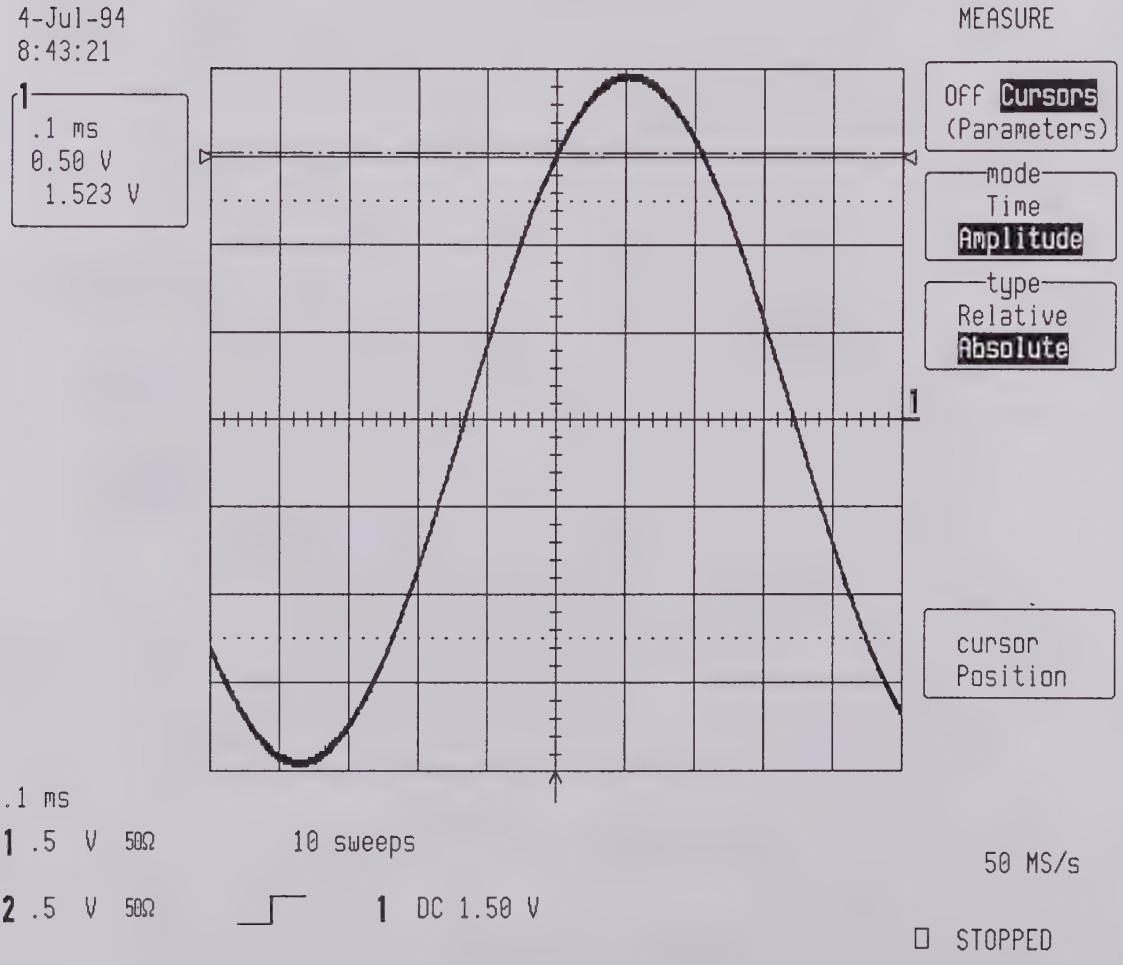
- Acquire few sweeps in Single Trigger mode.

- The sine wave must pass through the **horizontal center** of the screen at the **vertical + 3 divisions**.

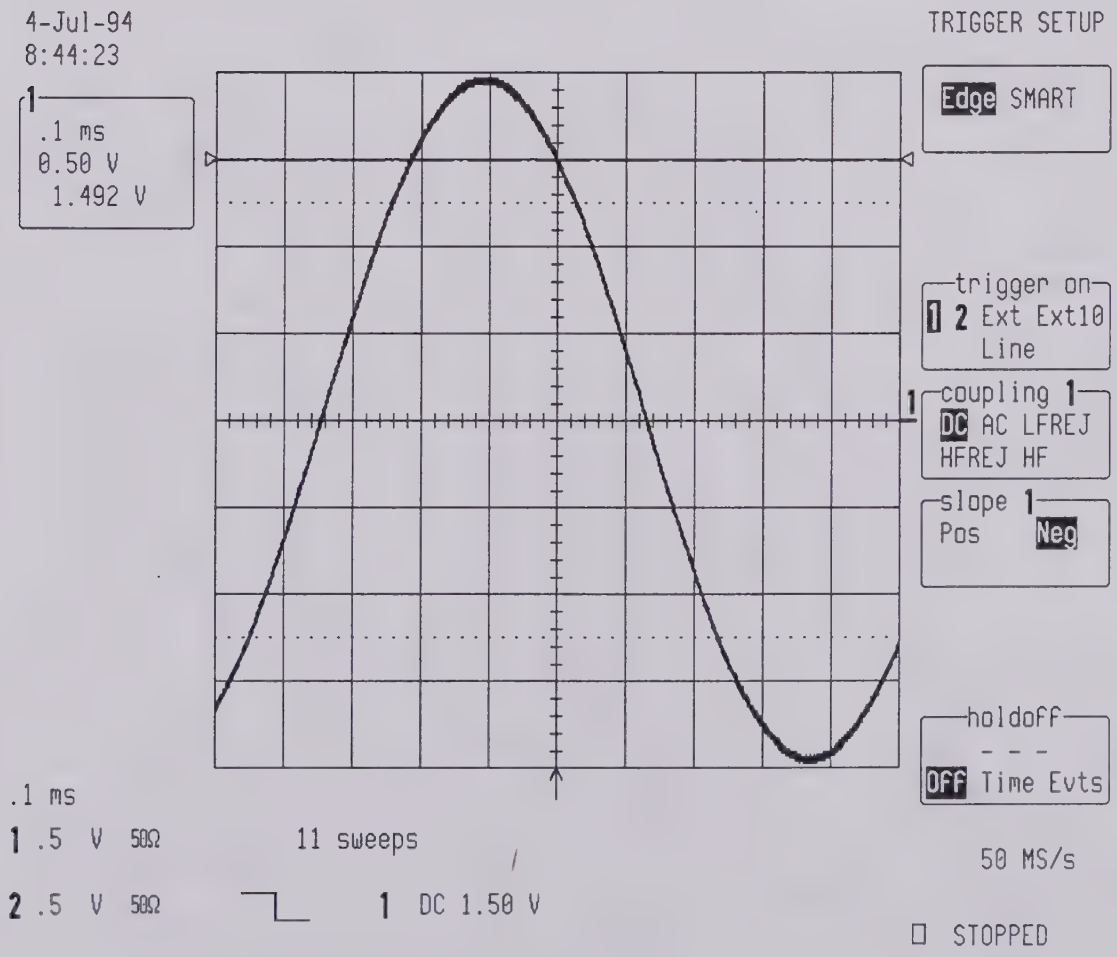
- Select Cursors/Measure : **Cursors, Amplitude, Absolute**

- Use the " cursor position " knob, to move the marker, at the **crossing point** of the **sine wave** and the **horizontal center of the screen** (50% pre-trigger line).

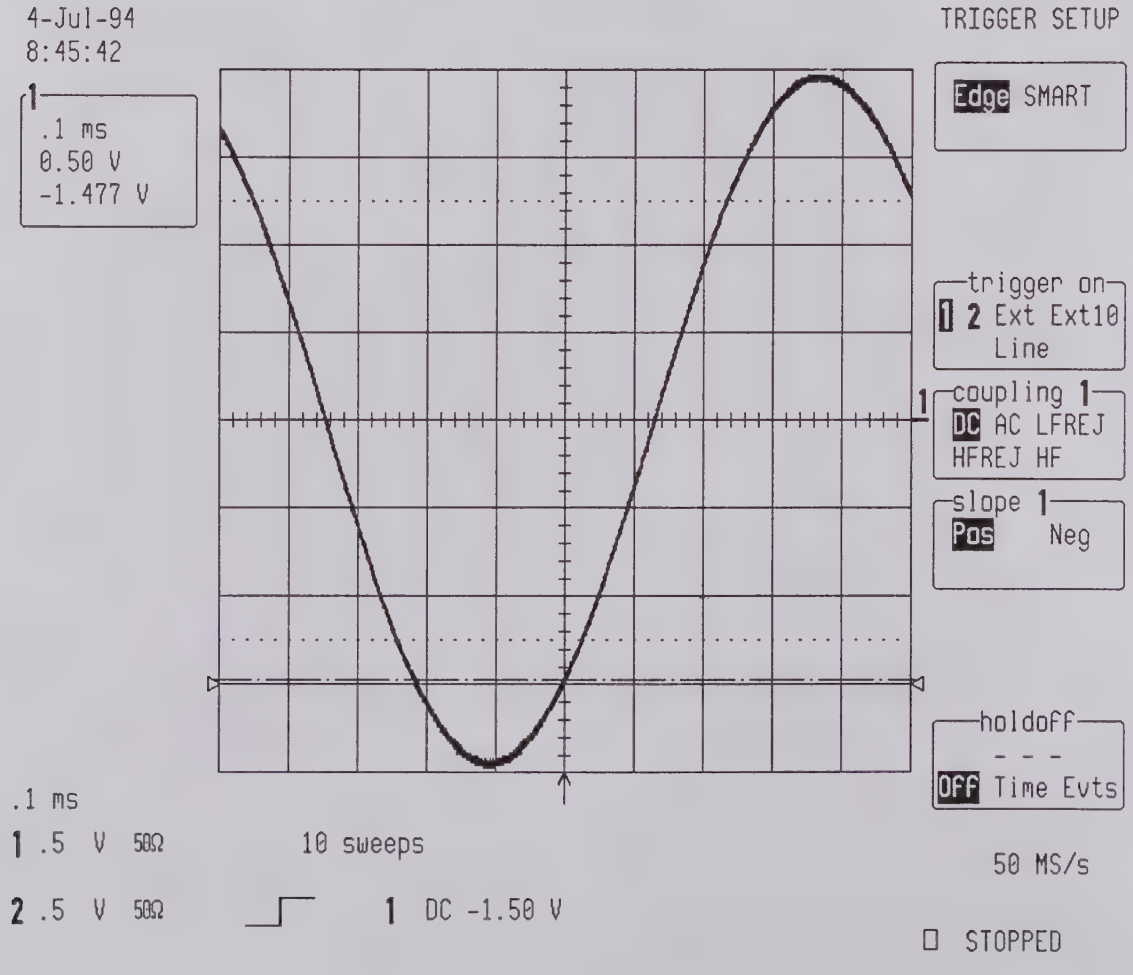
- Check that the **vertical crossing point level is + 1.5 V ± .2 V.** See icon **1** at top left.



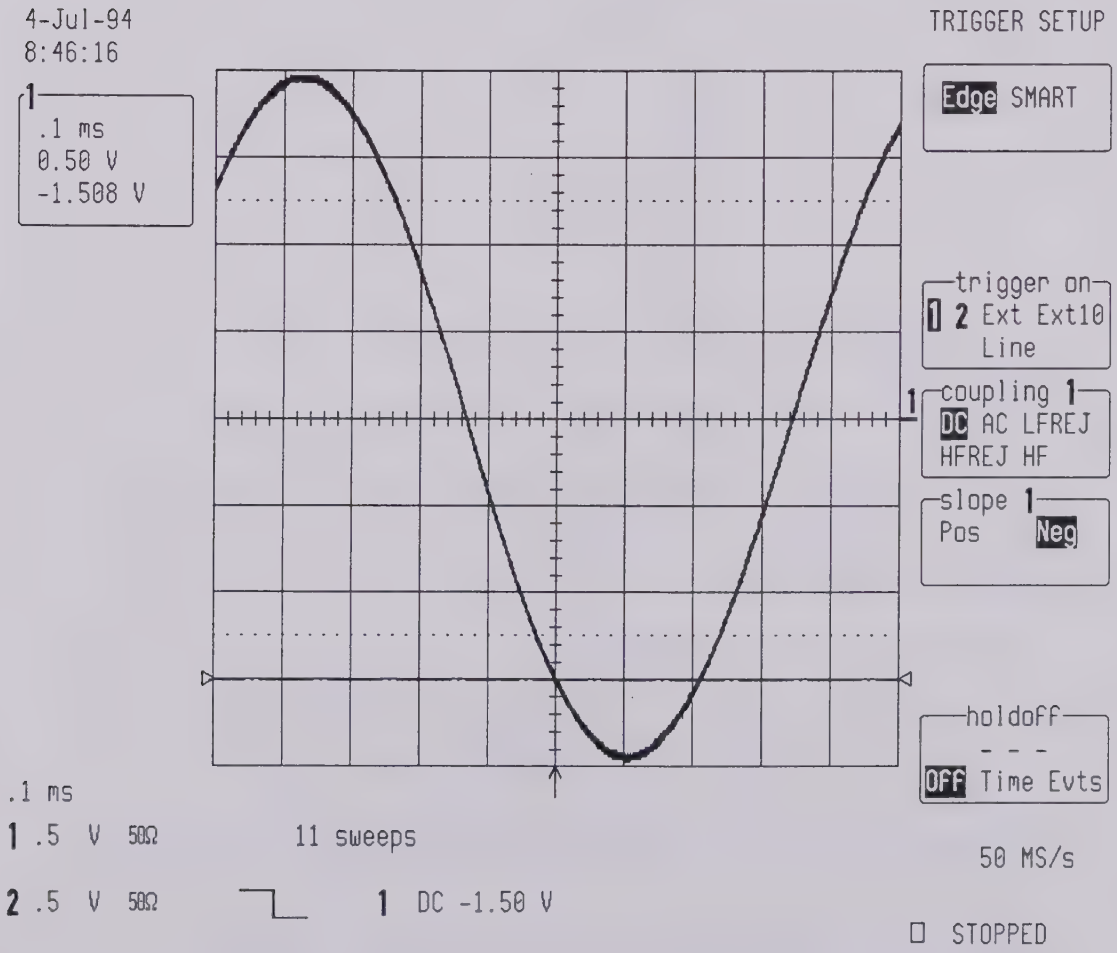
- Set Trigger Slope 1 : **Neg**
- Acquire few sweeps in Single Trigger mode.
- The sine wave must pass through the **horizontal center** of the screen at the **vertical + 3 divisions**.
- Select Cursors/Measure : **Cursors, Amplitude, Absolute**
- Use the " cursor position " knob, to move the marker, at the **crossing point** of the **sine wave** and the **horizontal center of the screen** (50% pre-trigger line).
- Check that the **vertical crossing point level is + 1.5 V ± .2 V.** See icon at top left.



- Set Trigger level : **DC - 1.5 V**
- Set Trigger Slope 1 : **Pos**
- Acquire few sweeps in Single Trigger mode.
- The sine wave must pass through the **horizontal center** of the screen at the **vertical - 3 divisions**.
- Select Cursors/Measure : **Cursors, Amplitude, Absolute**
- Use the " cursor position " knob, to move the marker, at the **crossing point** of the **sine wave** and the **horizontal center of the screen** (50% pre-trigger line).
- Check that the **vertical crossing point level is - 1.5 V ± .2 V.** See icon **1** at top left.



- Set Trigger Slope 1 : **Neg**
- Acquire few sweeps in Single Trigger mode.
- The sine wave must pass through the **horizontal center** of the screen at the **vertical - 3 divisions**.
- Select Cursors/Measure : **Cursors, Amplitude, Absolute**
- Use the " cursor position " knob, to move the marker, at the **crossing point** of the **sine wave** and the **horizontal center of the screen** (50% pre-trigger line).
- Check that the **vertical crossing point level is - 1.5 V ± .2 V.** See icon 1 at top left.



- Repeat step 3.10.2 for Channel 2, substituting channel control and input connector.

3.10.3 External Trigger

Specifications

External trigger range : DC ± .5 V

Procedure

- Connect the output of the generator to External input and to Channel 2 via a coaxial T-connector. The cable length from External to Channel 2 must be short, at most 2 nsec.

- Set frequency : **1 KHz**
- Turn on trace : **Ch2**
- Input Coupling Ch 2 : **DC 50 Ω**
- V/div. offset : **Normal**
- Input gain : **100 mV/div.**
- Input offset : **0 mV**
- Trigger setup : **Edge**
- Trigger on : **Ext**
- Coupling Ext : **DC**
- Slope Ext : **Pos**
- External : **DC 1MΩ**
- Set Ext Trigger level : **DC 0.0 mV**
- Mode : **Single**
- Pre-Trigger Delay : **50 %**
- Timebase : **.1 msec/div.**
- Channel use : **2**
- Record up to : **50 K samples**

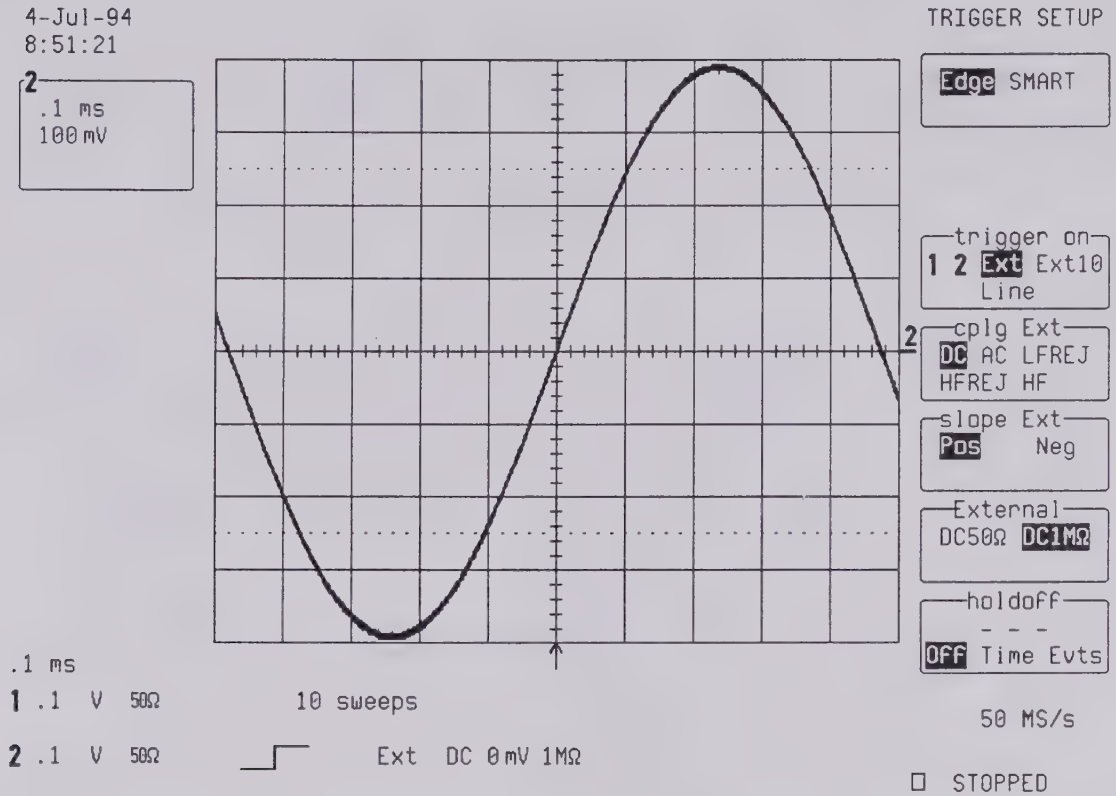
- Adjust the sine wave generator's output amplitude to get **8 divisions peak to peak**, corresponding to a **.8 V** amplitude.
- It is important that the offset of the input is set to **zero mV**, use show status and acquisition status to verify.

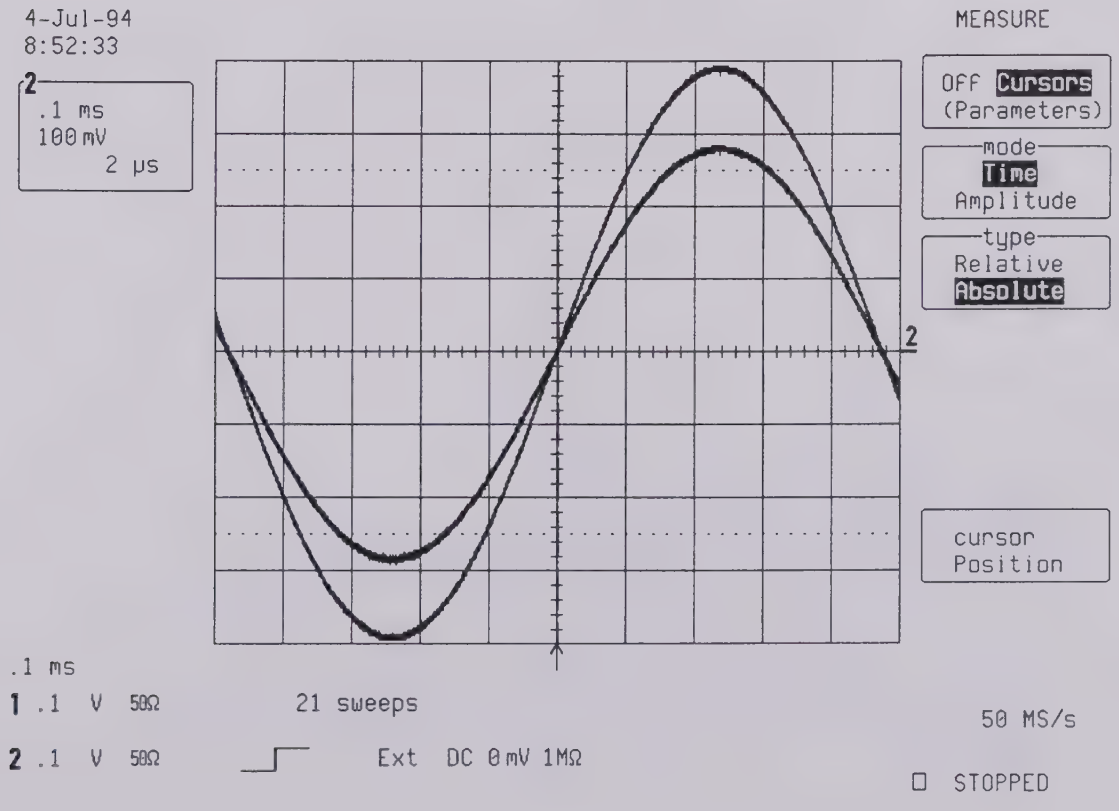
- Display setup : **Dot join Off**
- Set **Persistence On,** and acquire few sweeps in Single Trigger mode.

- Connect a **3 dB attenuator**, and acquire few more sweeps in Single mode.

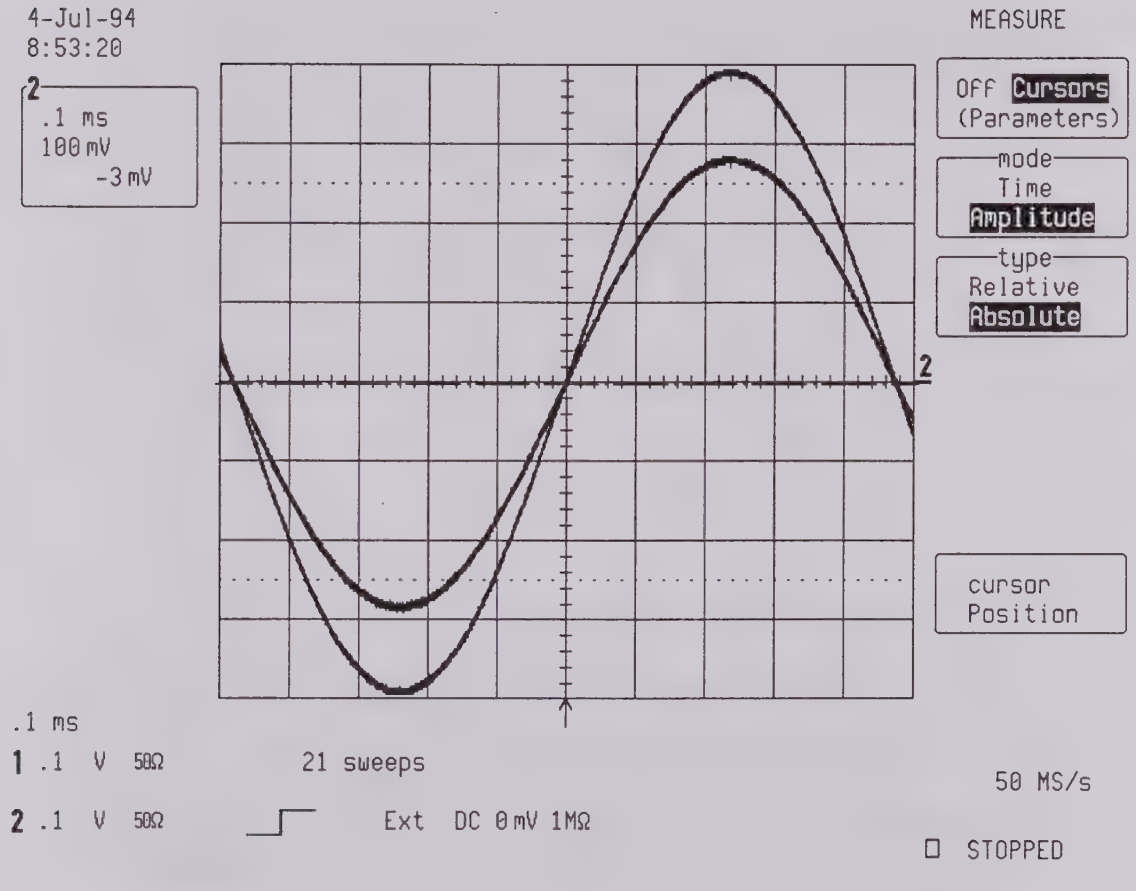
- Select Cursors/Measure : **Cursors, Time, Absolute**
- Use the " cursor position " knob, to move the marker at the **horizontal crossing point** of the two sine waves.

- Check that the **time** difference obtained between the marker and the trigger is within **± 20 µsec.** The time readout is below 100 mV in the icon **2,** at top left.

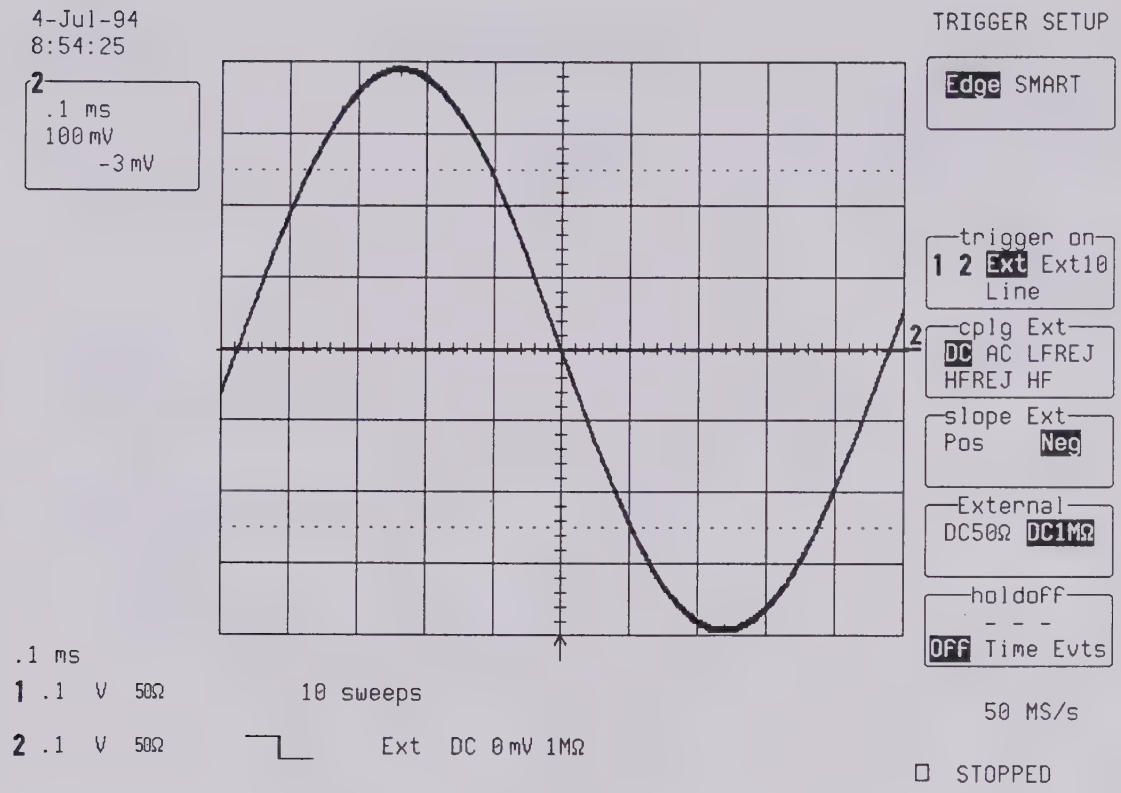

4-Jul-94
8:51:21
2
.1 ms
100 mV
TRIGGER SETUP
Edge SMART
trigger on
1 2 Ext Ext10
Line
cplg Ext
DC AC LFREJ
HFREJ HF
slope Ext
Pos Neg
External
DC50Ω DC1MΩ
holdoff
- - -
Off Time Evts
2
.1 ms
1 .1 V 50Ω
10 sweeps
50 MS/s
2 .1 V 50Ω
Ext DC 0 mV 1MΩ
STOPPED

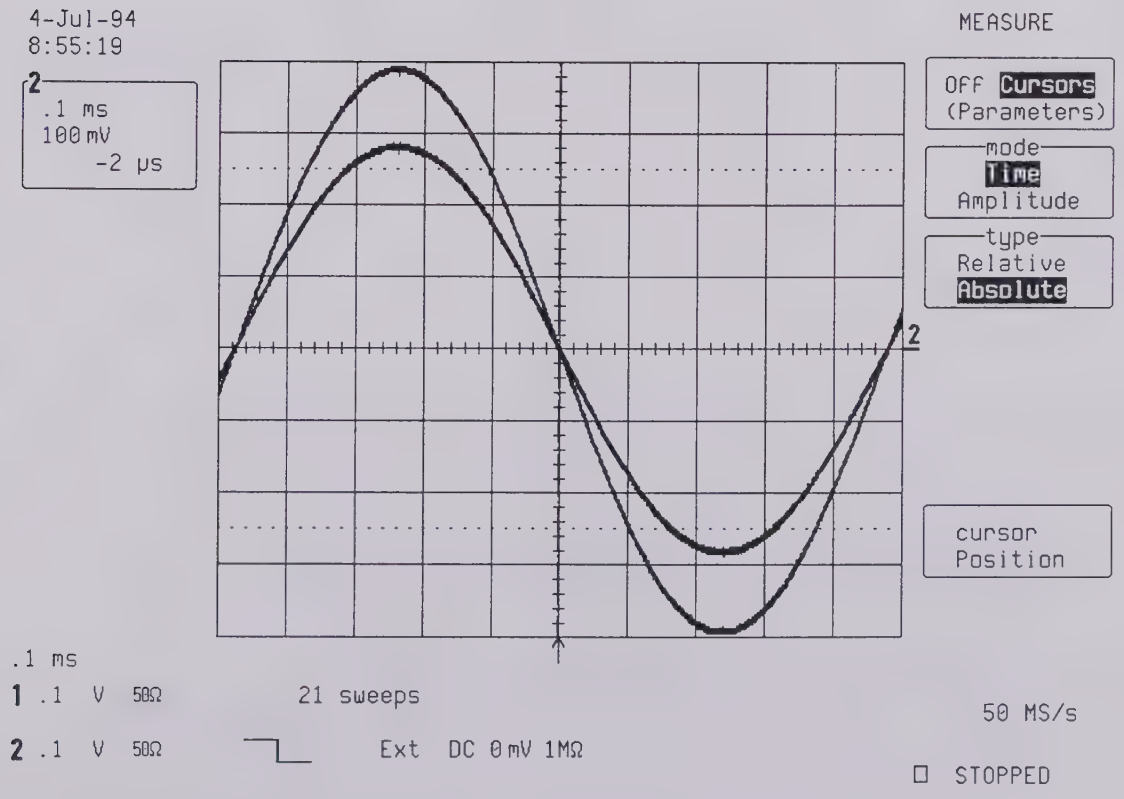

4-Jul-94
8:52:33
2
.1 ms
100 mV
2 µs
MEASURE
Off Cursors
(Parameters)
mode
Time
Amplitude
type
Relative
Absolute
2
cursor
Position
.1 ms
1 .1 V 50Ω
21 sweeps
50 MS/s
2 .1 V 50Ω
Ext DC 0 mV 1MΩ
STOPPED

- Select Cursors mode : **Amplitude, Absolute**
- Use the " cursor position " knob, to move the marker at the vertical crossing point of the two sine waves.
- Check that the **vertical crossing point level is within ± 40 mV.** See icon 2 at top left.



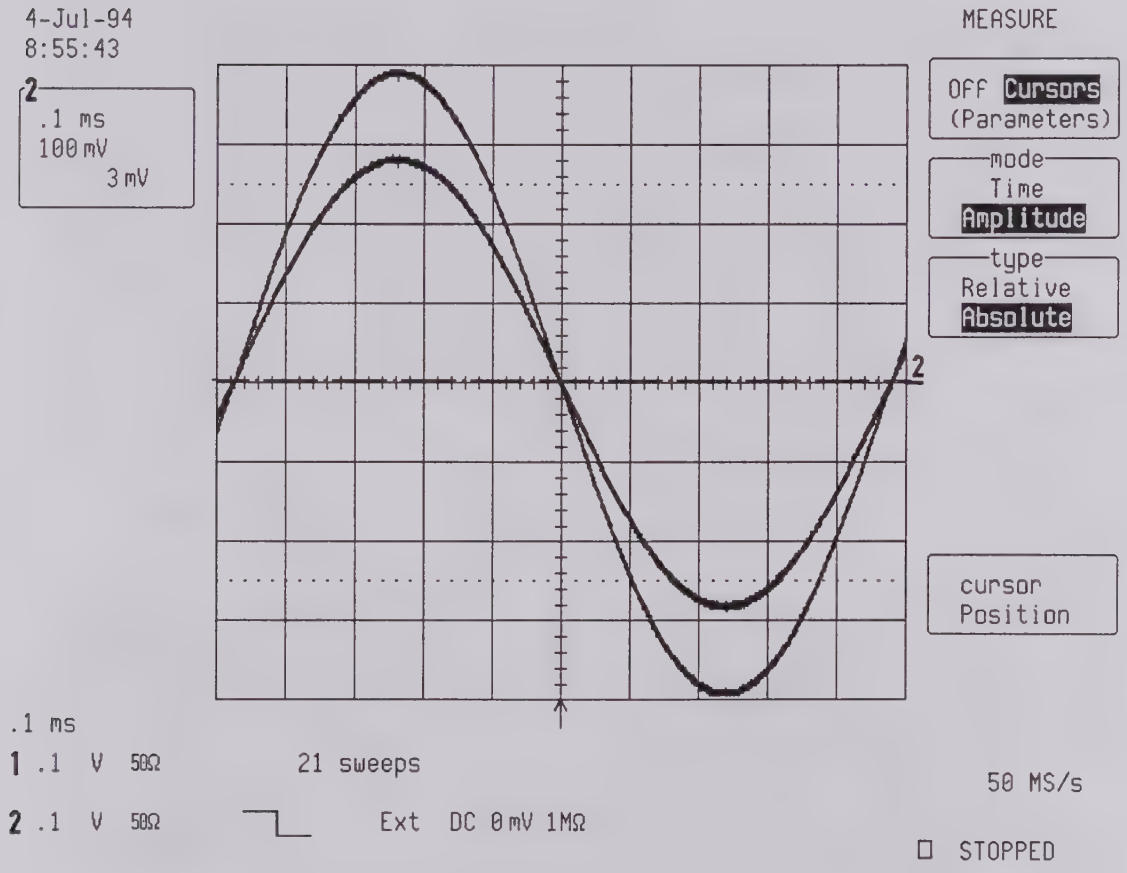
- Set Slope Ext : **Neg**
- Disconnect the **3 dB attenuator** from the BNC input
- Acquire few sweeps in Single Trigger mode.
- Connect the **3 dB attenuator**, and acquire few more sweeps in Single mode.
- Select Cursors/Measure : **Cursors, Time, Absolute**
- Use the " cursor position " knob, to move the marker at the **horizontal crossing point** of the two sine waves.
- Check that the **time** difference obtained between the marker and the trigger is within ± **20 µ sec.** The time readout is below 100 mV in the icon **2,** at top left.


4-Jul-94
8:54:25
2
.1 ms
100 mV
-3 mV
TRIGGER SETUP
Edge SMART
trigger on
1 2 Ext Ext10
Line
cplg Ext
DC AC LFREJ
HFREJ HF
slope Ext
Pos Neg
External
DC50Ω DC1MΩ
holdoff
- - -
Off Time Evts
2
.1 ms
1 .1 V 50Ω
10 sweeps
50 MS/s
2 .1 V 50Ω
Ext DC 0 mV 1MΩ
STOPPED


4-Jul-94
8:55:19
2
.1 ms
100 mV
-2 µs
MEASURE
Off Cursors
(Parameters)
mode
Time
Amplitude
type
Relative
Absolute
2
cursor
Position
.1 ms
1 .1 V 50Ω
21 sweeps
50 MS/s
2 .1 V 50Ω
Ext DC 0 mV 1MΩ
STOPPED

- Select Cursors mode : **Amplitude, Absolute**
- Use the " cursor position " knob, to move the marker at the **vertical crossing point** of the two sine waves.

- Check that the **voltage** difference obtained between the marker and the trigger level is within ± **40 mV.** The level readout is below 100 mV in the icon **2,** at top left.

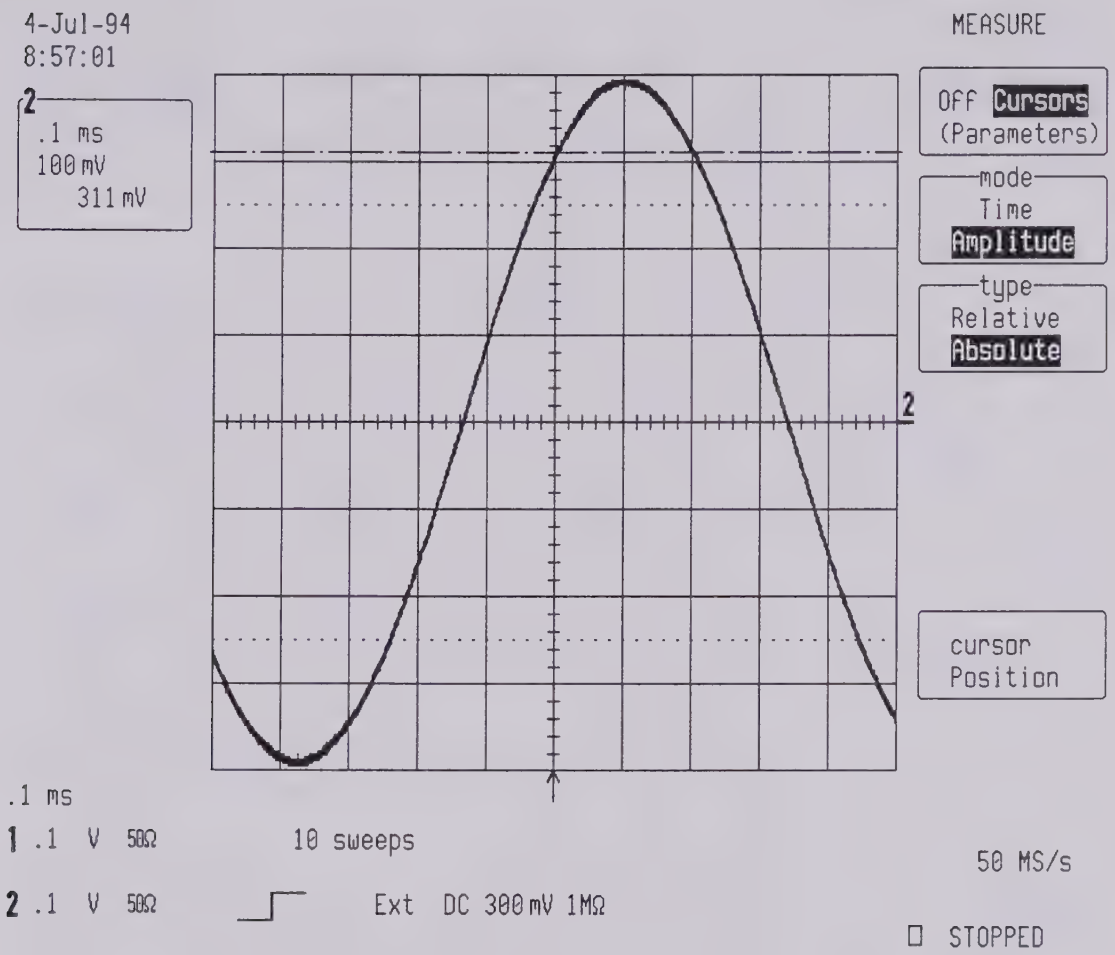


- Set Trigger level : **DC + 300 mV**

- Disconnect the **3 dB attenuator** from the BNC input
- Set Trigger Slope Ext : **Pos**
- Acquire few sweeps in Single Trigger mode.
- The sine wave must pass through the **horizontal center** of the screen at the **vertical + 3 divisions.**

- Select Cursors/Measure : **Cursors, Amplitude, Absolute**
- Use the " cursor position " knob, to move the marker, at the **crossing point** of the **sine wave** and the **horizontal center of the screen** (50% pre-trigger line).

- Check that the **vertical crossing point level is + 300 mV ± 40 mV.** See icon **2** at top.

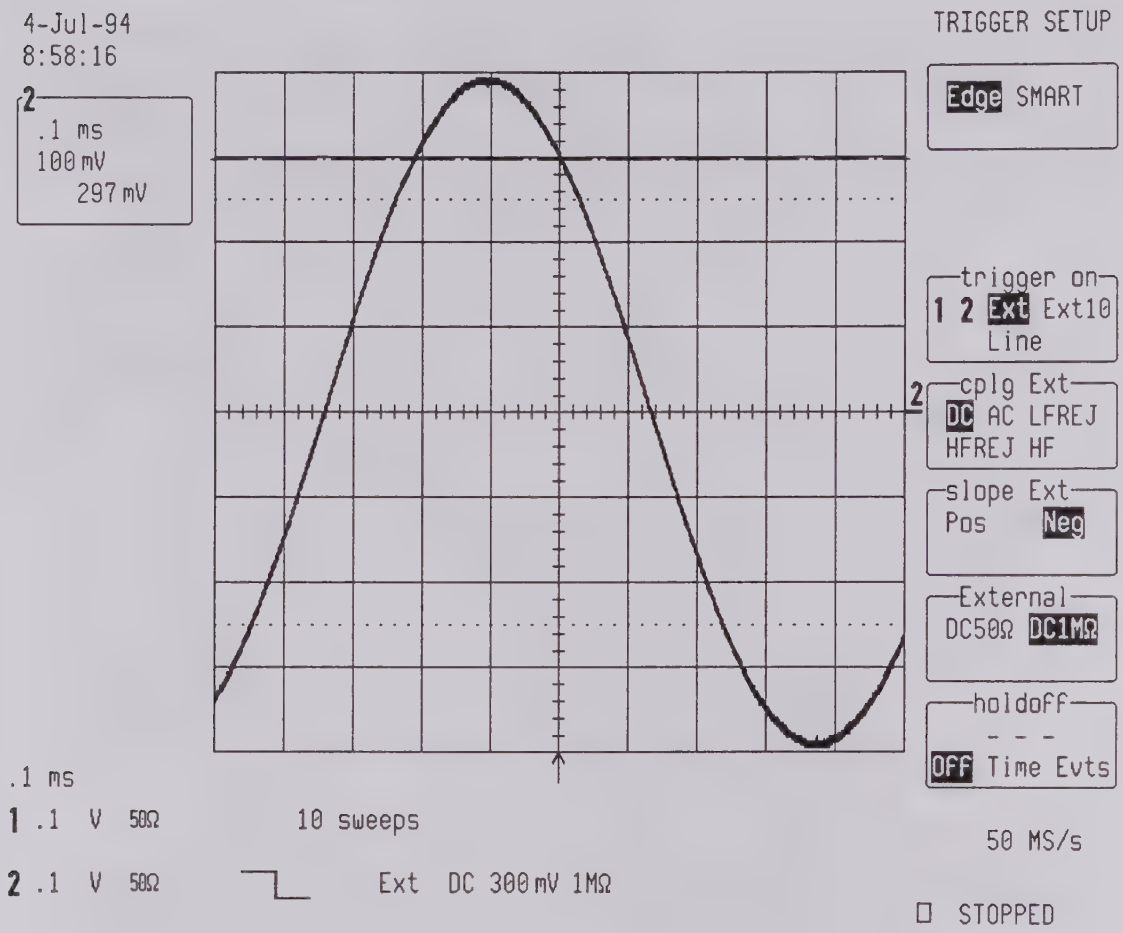


- Set Trigger Slope Ext : **Neg**

- Acquire few sweeps in Single Trigger mode.
- The sine wave must pass through the **horizontal center** of the screen at the **vertical + 3 divisions**.

- Select Cursors/Measure : **Cursors, Amplitude, Absolute**
- Use the " cursor position " knob, to move the marker, at the **crossing point** of the **sine wave** and the **horizontal center of the screen** (50% pre-trigger line).

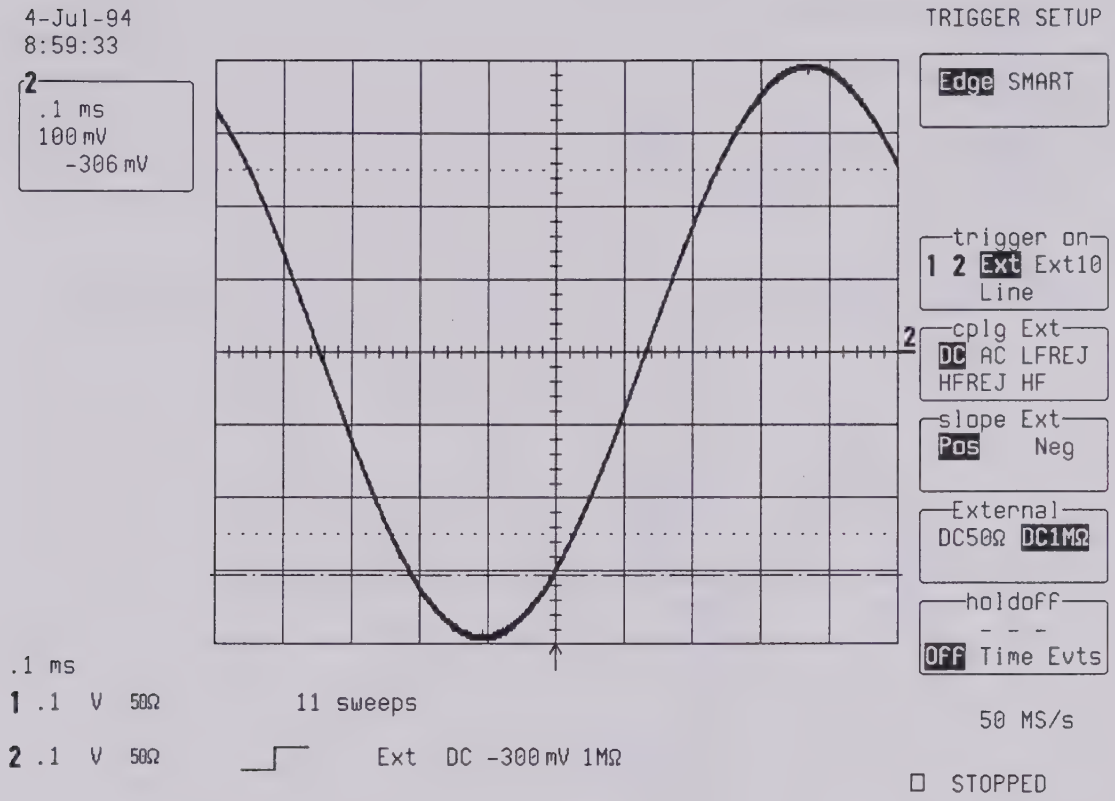
- Check that the **vertical crossing point level is + 300 mV ± 40 mV.** See icon 2 at top .

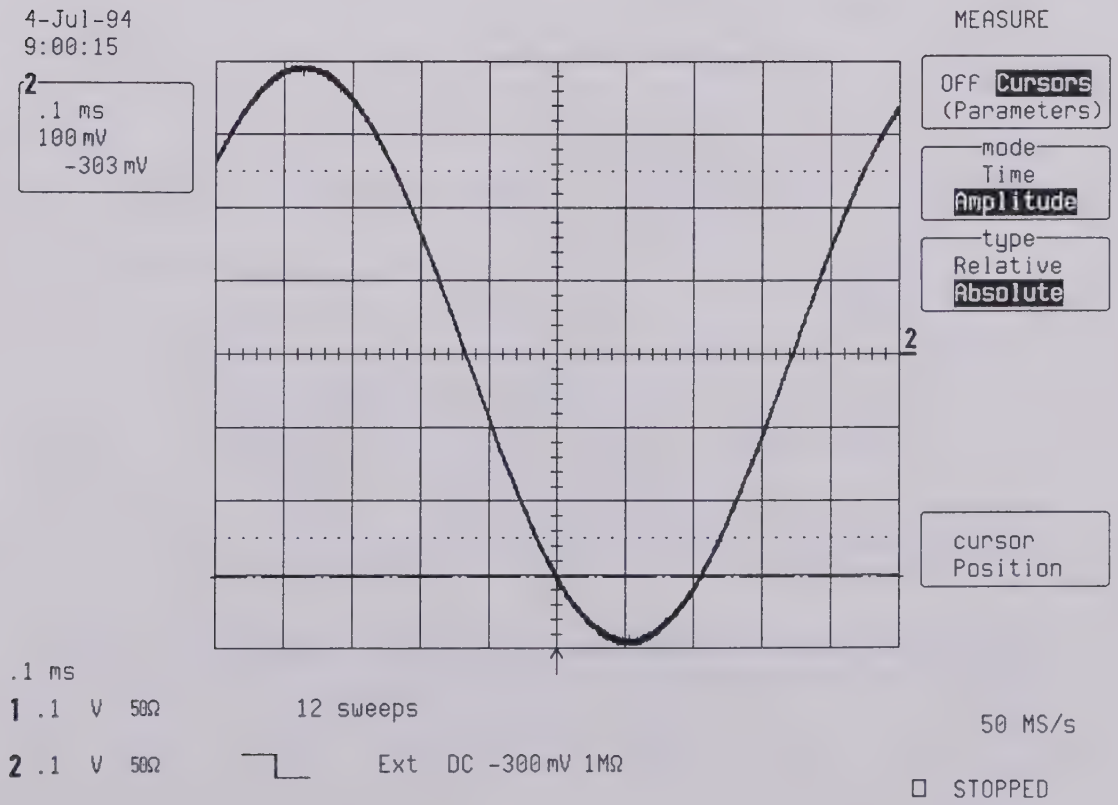


- Set Trigger level : **DC - 300 mV**

- Set Trigger Slope Ext : **Pos**
- Acquire few sweeps in Single Trigger mode.
- The sine wave must pass through the **horizontal center** of the screen at the **vertical - 3 divisions**.
- Select Cursors/Measure : **Cursors, Amplitude, Absolute**
- Use the " cursor position " knob, to move the marker, at the **crossing point** of the **sine wave** and the **horizontal center of the screen** (50% pre-trigger line).
- Check that the **vertical crossing point level is - 300 mV ± 40 mV.** See icon **2** at top.

- Set Trigger Slope Ext : **Neg**
- Acquire few sweeps in Single Trigger mode.
- The sine wave must pass through the **horizontal center** of the screen at the **vertical - 3 divisions**.
- Select Cursors/Measure : **Cursors, Amplitude, Absolute**
- Use the " cursor position " knob, to move the marker, at the **crossing point** of the **sine wave** and the **horizontal center of the screen** (50% pre-trigger line).
- Check that the **vertical crossing point level is - 300 mV ± 40 mV.** See icon **2** at top.


4-Jul-94
8:59:33
2
.1 ms
100 mV
-306 mV
TRIGGER SETUP
Edge SMART
trigger on
1 2 Ext Ext10
Line
cplg Ext
DC AC LFREJ
HFREJ HF
slope Ext
Pos Neg
External
DC50Ω DC1MΩ
holdoff
- - -
Off Time Evts
2
.1 ms
1 .1 V 50Ω
11 sweeps
50 MS/s
2 .1 V 50Ω
Ext DC -300 mV 1MΩ
STOPPED


4-Jul-94
9:00:15
2
.1 ms
100 mV
-303 mV
MEASURE
Off Cursors
(Parameters)
mode
Time
Amplitude
type
Relative
Absolute
2
cursor
Position
.1 ms
1 .1 V 50Ω
12 sweeps
50 MS/s
2 .1 V 50Ω
Ext DC -300 mV 1MΩ
STOPPED

3.10.4 External /10 Trigger

Specifications

External trigger range : DC ± 5 V

Procedure

- Connect the output of the generator to External input and to Channel 2 via a coaxial T-connector. The cable length from External to Channel 2 must be short, at most 2 nsec.
- Set frequency : **1 KHz**

- Turn on trace : **Ch2**
- Input Coupling Ch 2 : **DC 50 Ω**
- V/div. offset : **Normal**
- Input gain : **1 V/div.**
- Input offset : **0 mV**
- Trigger setup : **Edge**
- Trigger on : **Ext10**
- Coupling Ext10 : **DC**
- Slope Ext10 : **Pos**
- External : **DC 1MΩ**
- Set Ext Trigger level : **DC 0.0 mV**
- Mode : **Single**
- Pre-Trigger Delay : **50 %**
- Timebase : **.1 msec/div.**
- Channel use : **2**
- Record up to : **50 K samples**

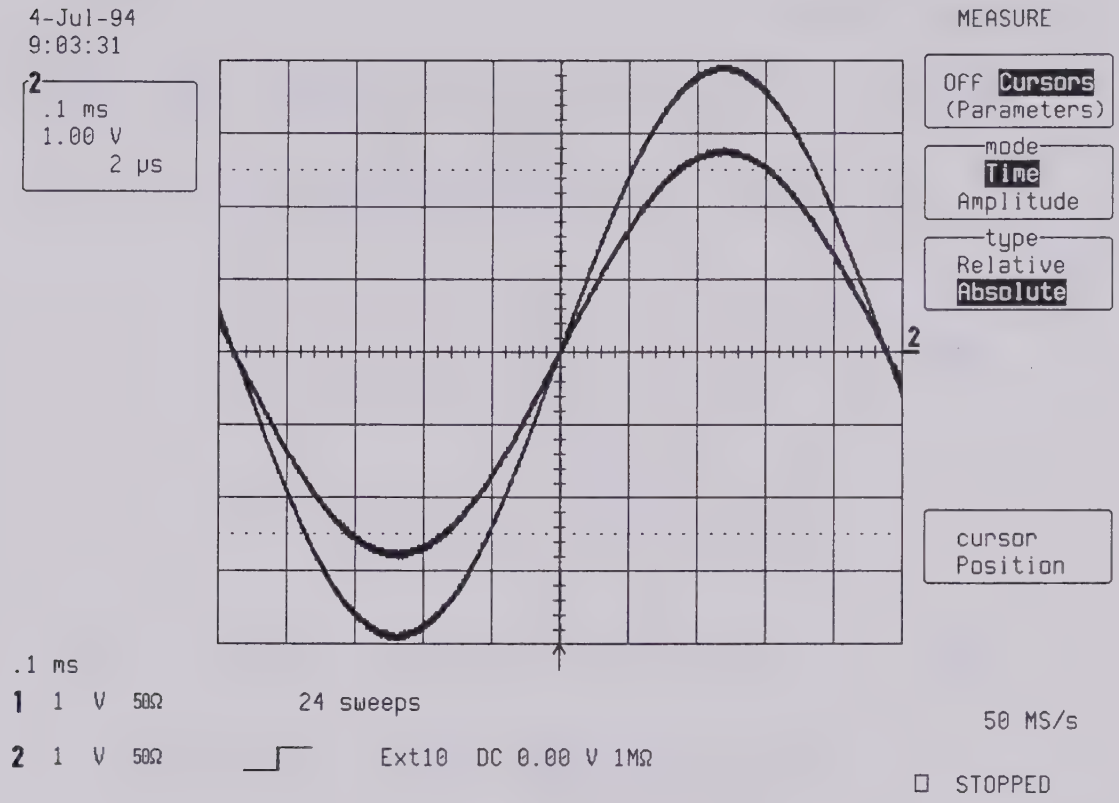
- Adjust the sine wave generator's output amplitude to get **8 divisions peak to peak**, corresponding to a **8 V** amplitude.
- It is important that the offset of the input is set to **zero mV**, use show status and acquisition status to verify.

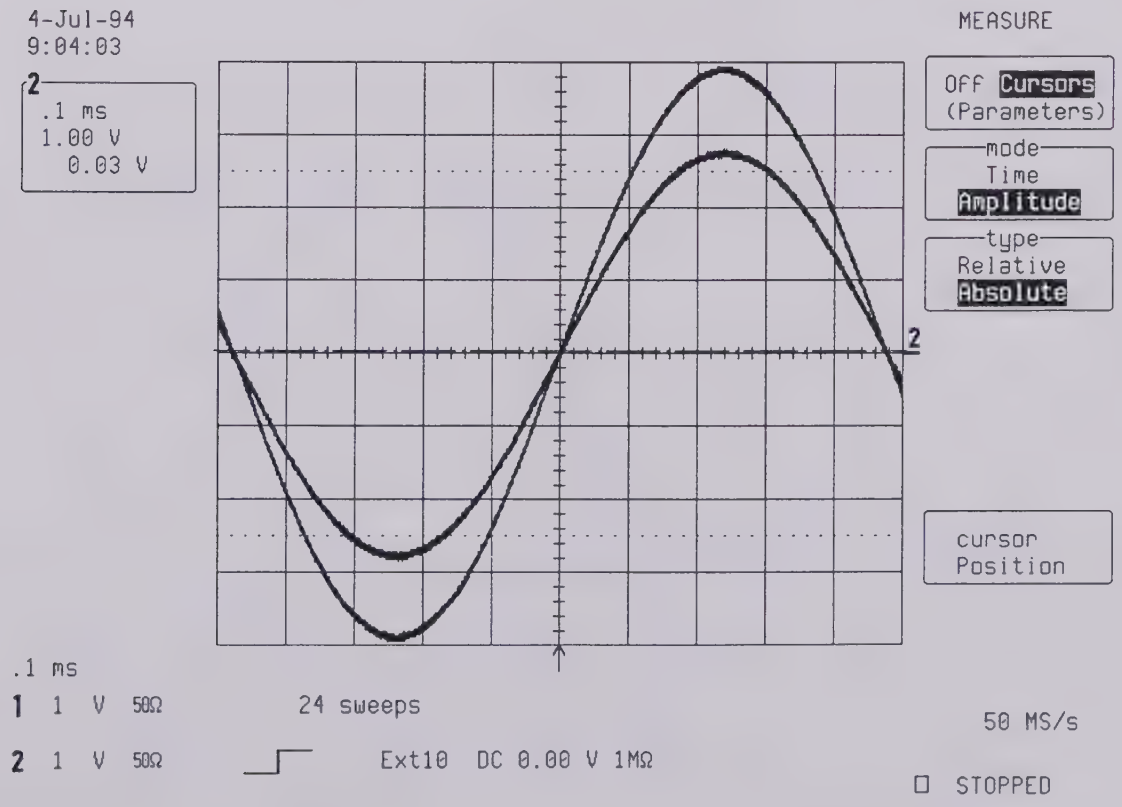
- Display setup : **Dot join Off**
- Set **Persistence On,** and acquire few sweeps in Single Trigger mode.

- Connect a **3 dB attenuator**, and acquire few more sweeps in Single mode.

- Select Cursors/Measure : **Cursors, Time, Absolute**
- Use the " cursor position " knob, to move the marker at the **horizontal crossing point** of the two sine waves.

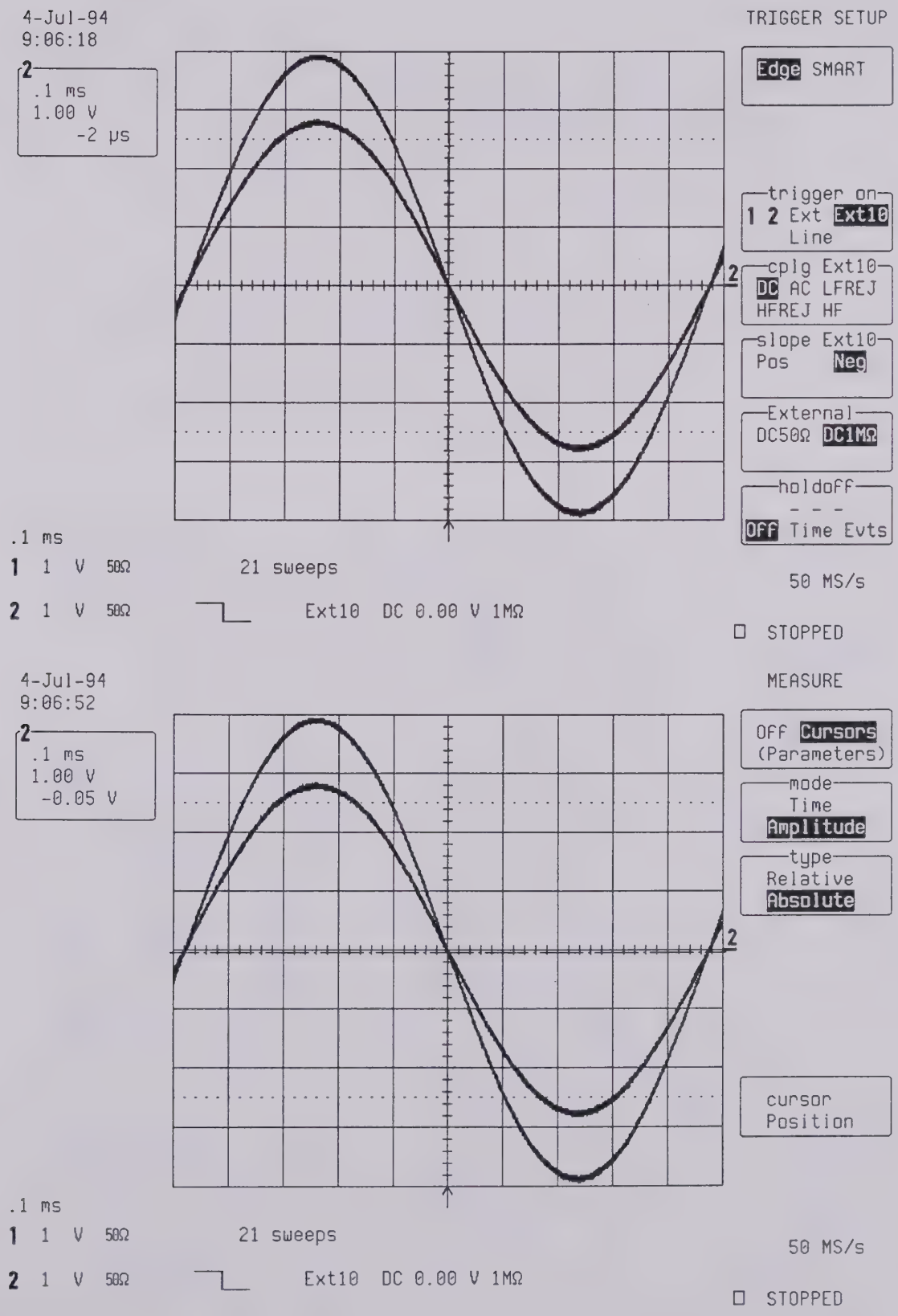
- Check that the **time** difference obtained between the marker and the trigger is within **± 20 µsec.** The time readout is below 1 V in the icon **2,** at top left.


4-Jul-94
9:03:31
2
.1 ms
1.00 V
2 µs
MEASURE
Off Cursors
(Parameters)
mode
Time
Amplitude
type
Relative
Absolute
cursor
Position
2
.1 ms
1 1 V 50Ω
24 sweeps
50 MS/s
2 1 V 50Ω
Ext10 DC 0.00 V 1MΩ
STOPPED


4-Jul-94
9:04:03
2
.1 ms
1.00 V
0.03 V
MEASURE
Off Cursors
(Parameters)
mode
Time
Amplitude
type
Relative
Absolute
cursor
Position
2
.1 ms
1 1 V 50Ω
24 sweeps
50 MS/s
2 1 V 50Ω
Ext10 DC 0.00 V 1MΩ
STOPPED

- Select Cursors mode : **Amplitude, Absolute**
- Use the " cursor position " knob, to move the marker at the **vertical crossing point** of the two sine waves.
- Check that the **voltage** difference obtained between the marker and the trigger level is within ± **400 mV.** The level readout is below 1 V in the icon **2,** at top left.

- Set Trigger Slope Ext10 : **Neg**
- Disconnect the **3 dB attenuator** from the BNC input
- Acquire few sweeps in Single Trigger mode.
- Connect the **3 dB attenuator**, and acquire few more sweeps in Single mode.
- Select Cursors/Measure : **Cursors, Time, Absolute**
- Use the " cursor position " knob, to move the marker at the **horizontal crossing point** of the two sine waves.
- Check that the **time** difference obtained between the marker and the trigger is within ± **20 μ sec.** The time readout is below 1 V in the icon **2,** at top left.
- Select Cursors mode : **Amplitude, Absolute**
- Use the " cursor position " knob, to move the marker at the **vertical crossing point** of the two sine waves.
- Check that the **vertical crossing point level is within ± 400 mV.** See icon **2** at left.


4-Jul-94
9:06:18
2
.1 ms
1.00 V
-2 µs
TRIGGER SETUP
Edge SMART
trigger on
1 2 Ext Ext10
Line
cplg Ext10
DC AC LFREJ
HFREJ HF
slope Ext10
Pos Neg
External
DC50Ω DC1MΩ
holdoff
- - -
Off Time Evts
.1 ms
1 1 V 50Ω
21 sweeps
50 MS/s
2 1 V 50Ω
Ext10 DC 0.00 V 1MΩ
STOPPED
4-Jul-94
9:06:52
2
.1 ms
1.00 V
-0.05 V
MEASURE
Off Cursors
(Parameters)
mode
Time
Amplitude
type
Relative
Absolute
cursor
Position
.1 ms
1 1 V 50Ω
21 sweeps
50 MS/s
2 1 V 50Ω
Ext10 DC 0.00 V 1MΩ
STOPPED

- Set Trigger level : **DC + 3 V**

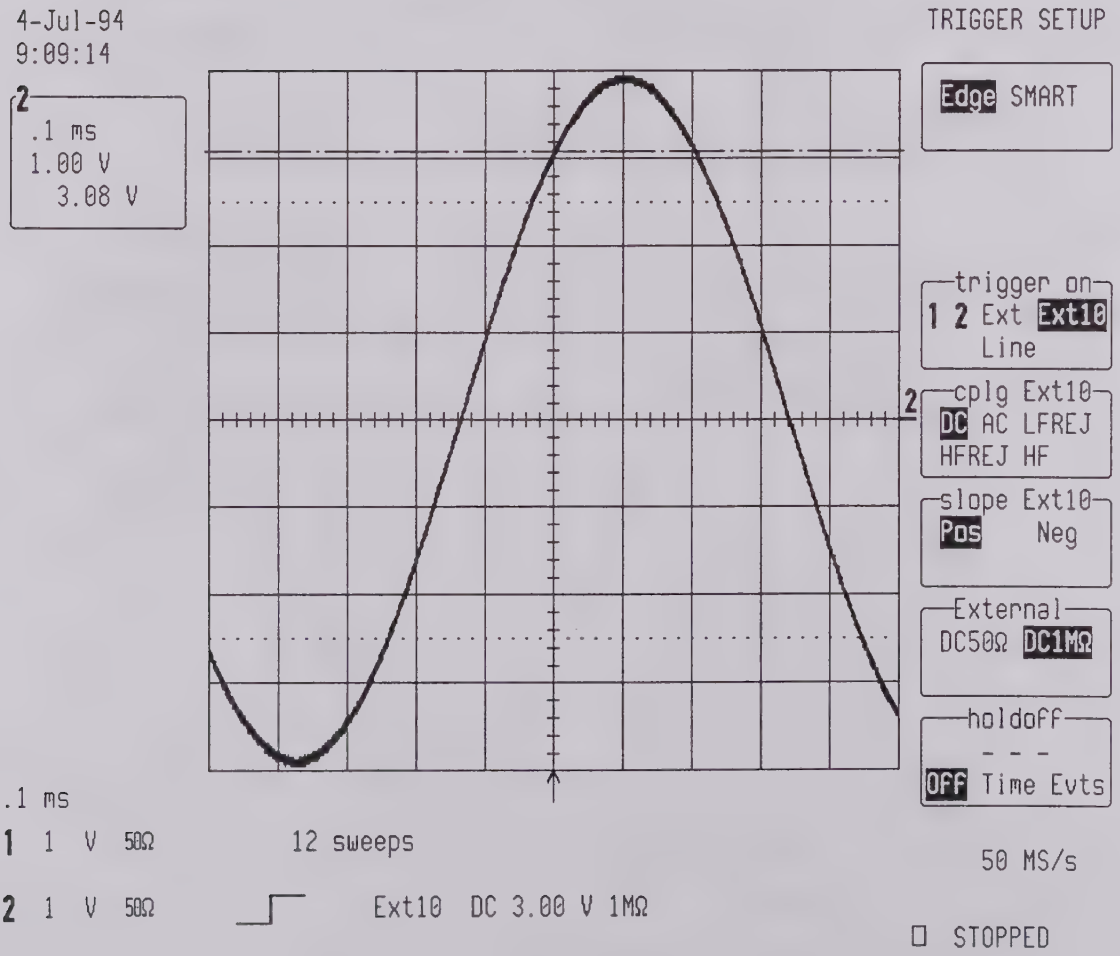
- Set Trigger Slope Ext10 : **Pos**
- Disconnect the **3 dB attenuator** from the BNC input
- Acquire few sweeps in Single Trigger mode.

- The sine wave must pass through the **horizontal center** of the screen at the **vertical + 3 divisions**.

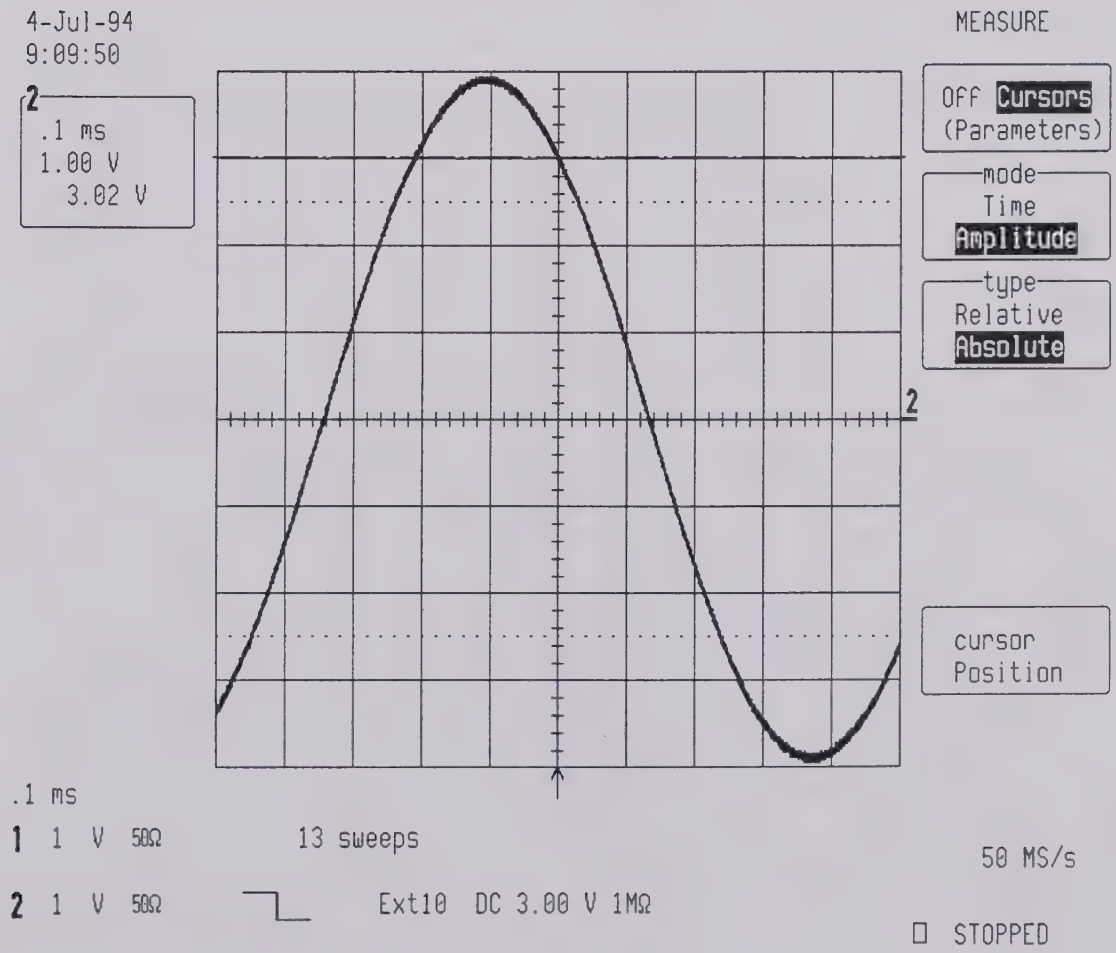
- Select Cursors/Measure : **Cursors, Amplitude, Absolute**

- Use the " cursor position " knob, to move the marker, at the **crossing point** of the **sine wave** and the **horizontal center of the screen** (50% pre-trigger line).

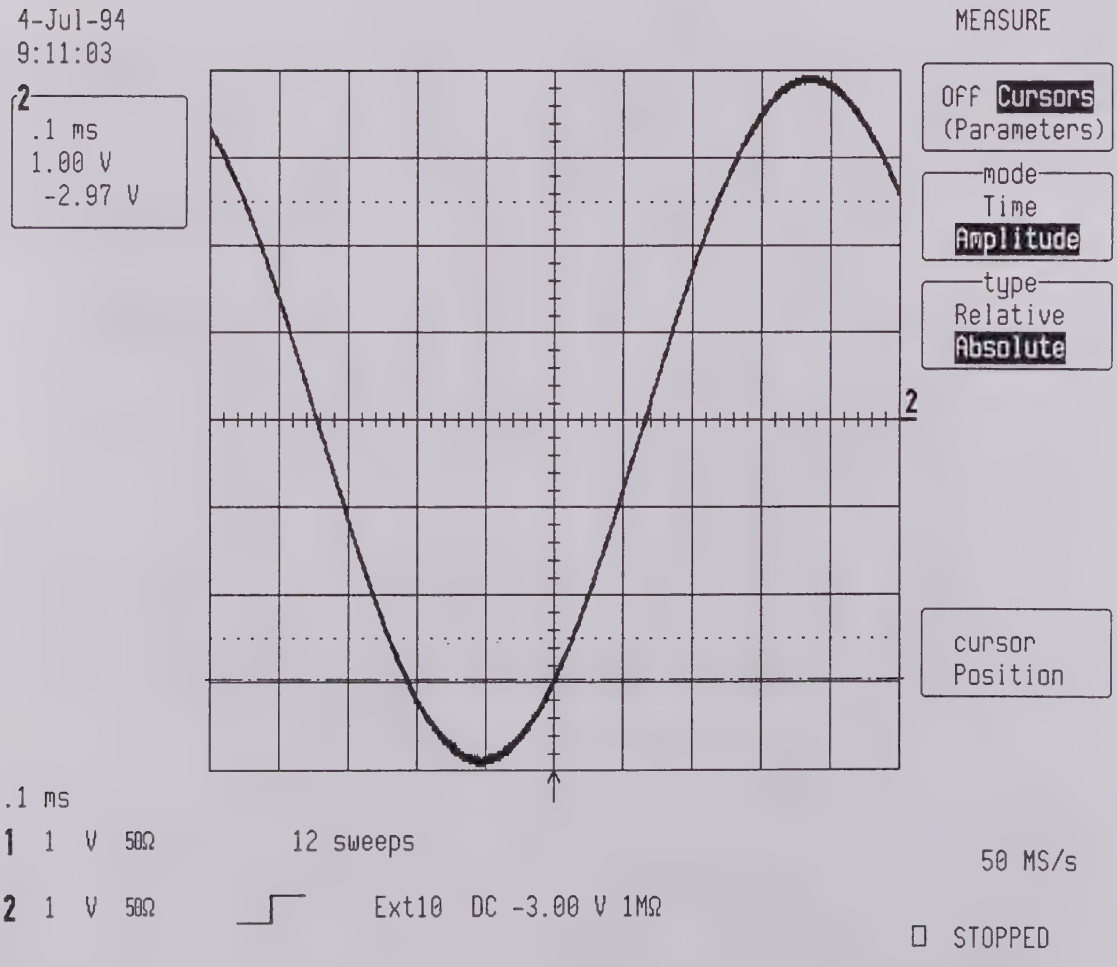
- Check that the **vertical crossing point level is + 3 V ± 400 mV.** See icon **2** at top.



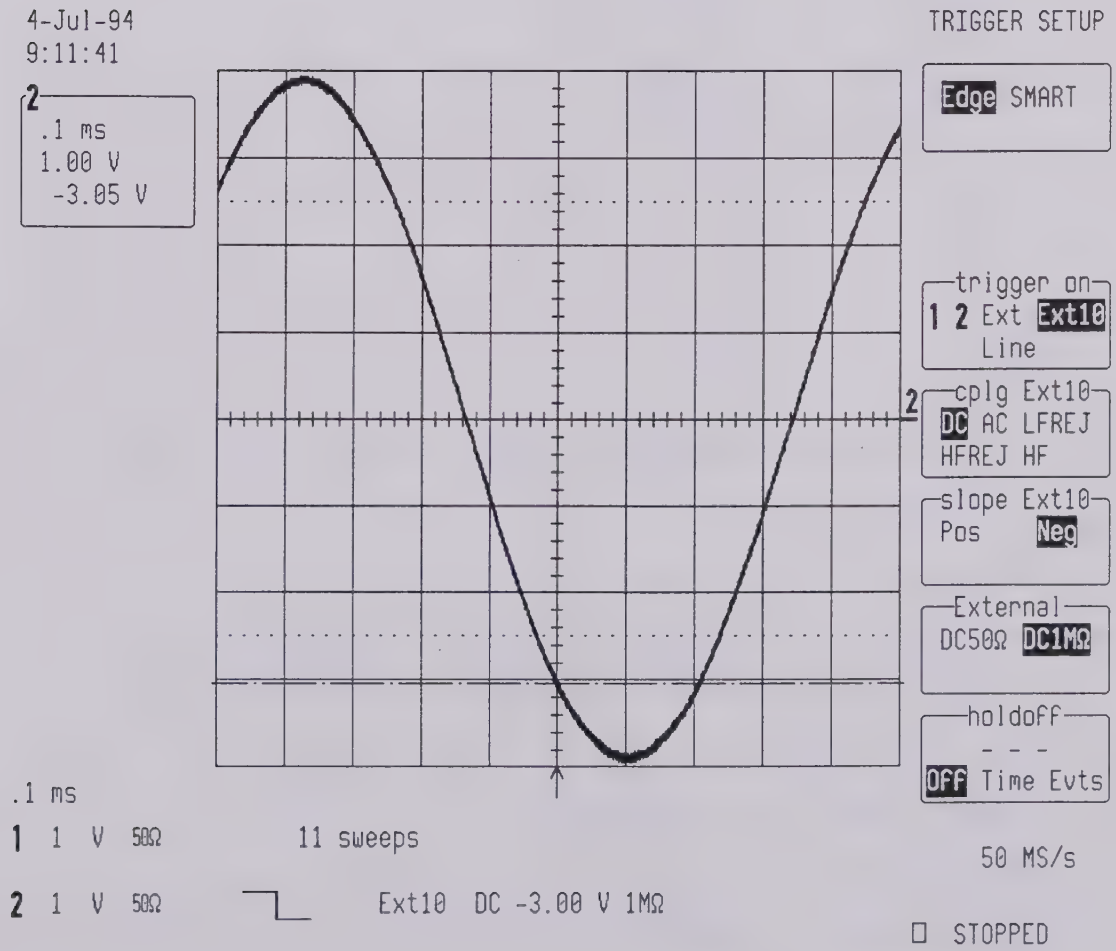
- Set Trigger Slope Ext10 : **Neg**
- Acquire few sweeps in Single Trigger mode.
- The sine wave must pass through the **horizontal center** of the screen at the **vertical + 3 divisions**.
- Select Cursors/Measure : **Cursors, Amplitude, Absolute**
- Use the " cursor position " knob, to move the marker, at the **crossing point** of the **sine wave** and the **horizontal center of the screen** (50% pre-trigger line).
- Check that the **vertical crossing point level is + 3 V ± 400 mV.** See icon **2** at top .



- Set Trigger level : **DC - 3 V**
- Trigger Slope Ext10 : **Pos**
- Acquire few sweeps in Single Trigger mode.
- The sine wave must pass through the **horizontal center** of the screen at the **vertical - 3 divisions**.
- Select Cursors/Measure : **Cursors, Amplitude, Absolute**
- Use the " cursor position " knob, to move the marker, at the **crossing point** of the **sine wave** and the **horizontal center of the screen** (50% pre-trigger line).
- Check that the **vertical crossing point level is - 3 V ± 400 mV.** See icon **2** at top.



- Trigger Slope Ext10 : **Neg**
- Acquire few sweeps in Single Trigger mode.
- The sine wave must pass through the **horizontal center** of the screen at the **vertical - 3 divisions**.
- Select Cursors/Measure : **Cursors, Amplitude, Absolute**
- Use the " cursor position " knob, to move the marker, at the **crossing point** of the **sine wave** and the **horizontal center of the screen** (50% pre-trigger line).
- Check that the **vertical crossing point level is - 3 V ± 400 mV.** See icon 2 at top.



3.11 Smart Trigger

Specifications

Pulse width < or > 2.5 nsec to 20 sec.

3.11.1 Trigger on Pulse Width < 10 nsec

Procedure

- Connect a leveled sine wave generator to Channel 1

- Frequency : **100 MHz**
- Turn on trace : **Ch1**
- Display setup : **Standard, Persistence off, Dot join on, Single grid**
- Input Coupling : **DC 50 Ω**
- V/div. offset : **Normal**
- Global BWL : **Off**
- Probe atten : **X1**
- Input gain : **.5 V/div.**
- Trigger setup : **Smart**
- Setup Smart Trigger : **Glitch**
- Trigger on : **1**
- Coupling 1 : **DC**
- Trigger Level : **0.0 V**
- At end of : **Neg**
- Width : **< 10 nsec**
- Mode : **Norm**
- Timebase : **5 nsec/div.**

- Adjust the generator output amplitude to get a five division amplitude sine wave.

- Check that the scope triggers

- Switch to Width : **> 10 nsec**

- Check that the scope **doesn't trigger** : slow trigger and no flashes in box next to normal.

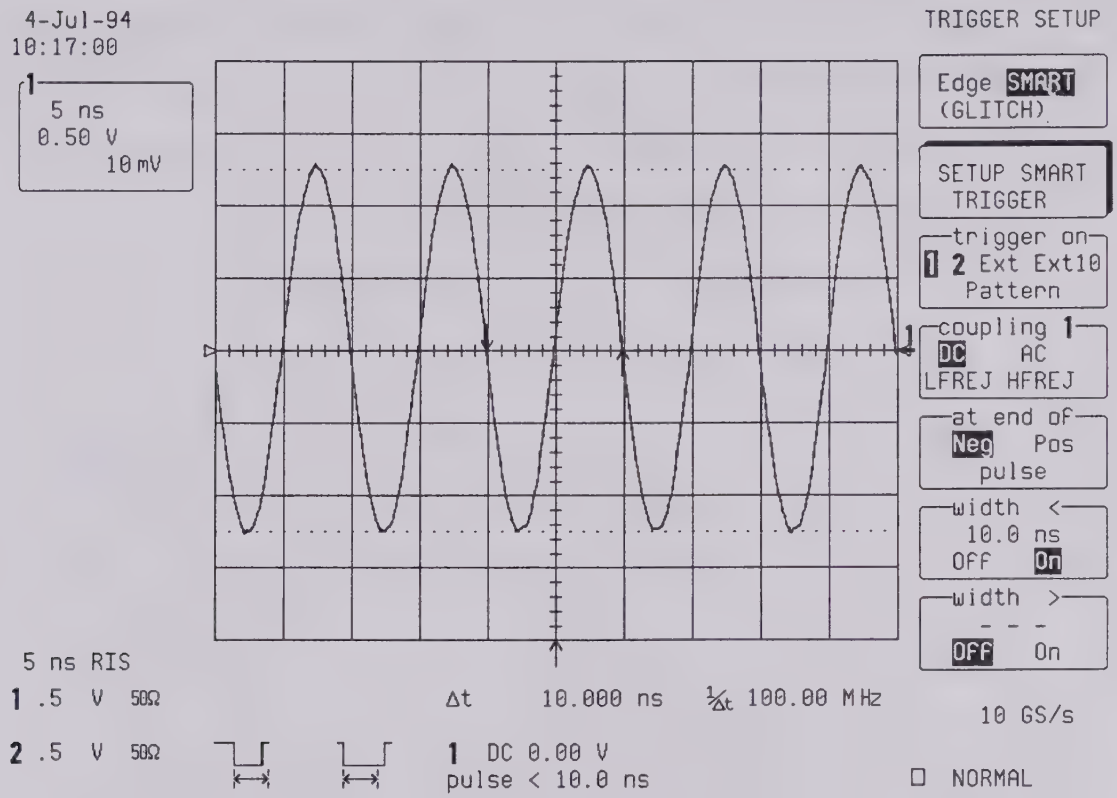
3.11.2 Trigger on Pulse Width > 10 nsec

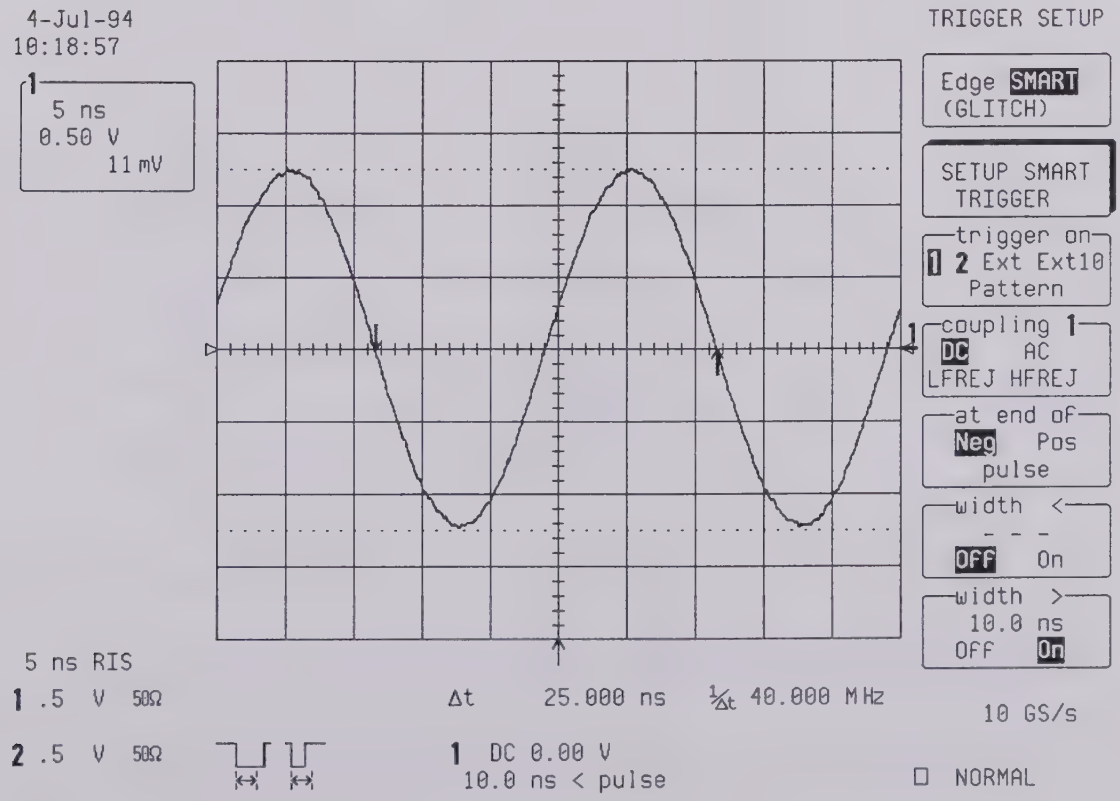
- Adjust the generator frequency to **40 MHz**

- Check that the scope triggers

- Switch to Width : **< 10 nsec**

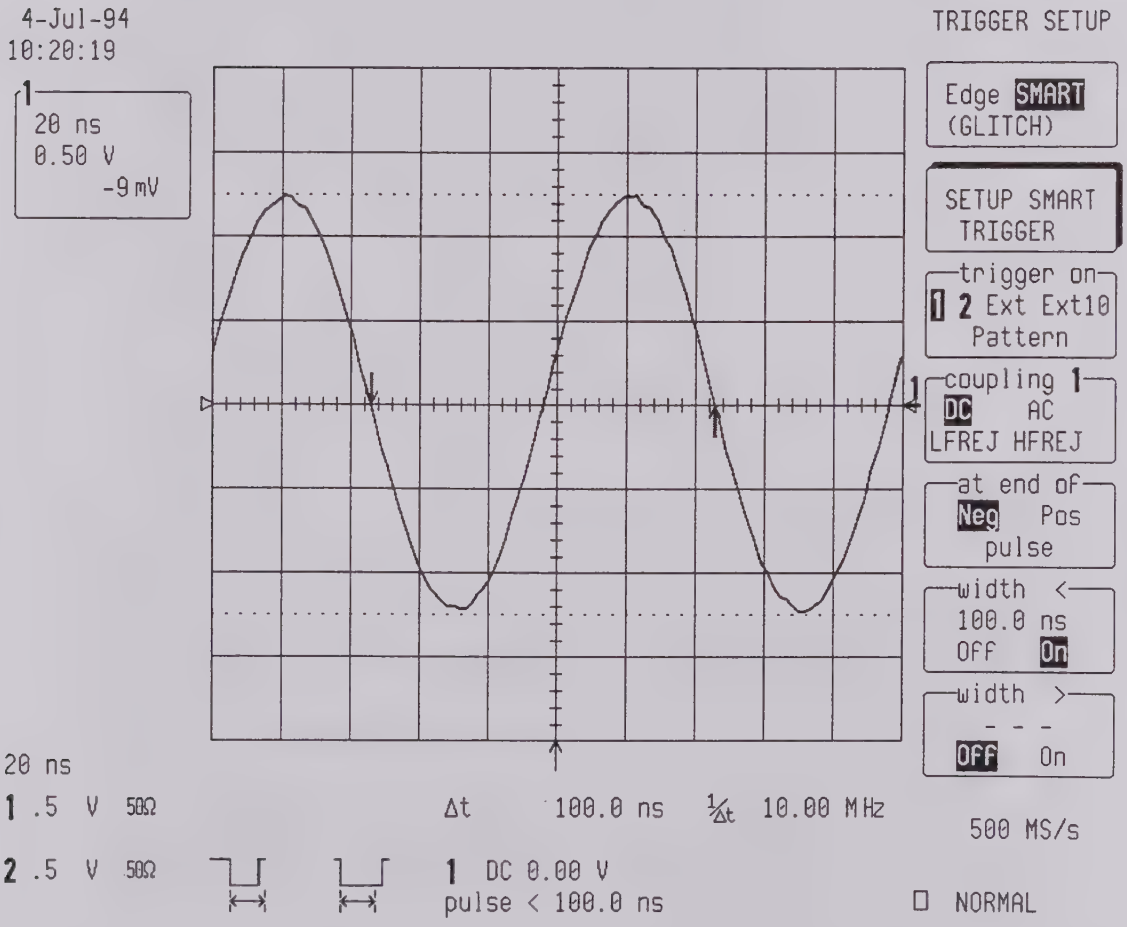
- Check that the scope **doesn't trigger** : slow trigger and no flashes in box next to normal.


4-Jul-94
10:17:00
1
5 ns
0.50 V
10 mV
TRIGGER SETUP
Edge SMART
(GLITCH)
SETUP SMART
TRIGGER
trigger on
1 2 Ext Ext10
Pattern
coupling 1
DC AC
LFREJ HFREJ
at end of
Neg Pos
pulse
width <
10.0 ns
Off On
width >
- - -
Off On
5 ns RIS
1 .5 V 50Ω
2 .5 V 50Ω
Δt 10.000 ns
1/Δt 100.00 MHz
10 GS/s
1 DC 0.00 V
pulse < 10.0 ns
NORMAL


4-Jul-94
10:18:57
1
5 ns
0.50 V
11 mV
TRIGGER SETUP
Edge SMART
(GLITCH)
SETUP SMART
TRIGGER
trigger on
1 2 Ext Ext10
Pattern
coupling 1
DC AC
LFREJ HFREJ
at end of
Neg Pos
pulse
width <
- - -
Off On
width >
10.0 ns
Off On
5 ns RIS
1 .5 V 50Ω
2 .5 V 50Ω
Δt 25.000 ns
1/Δt 40.000 MHz
10 GS/s
1 DC 0.00 V
10.0 ns < pulse
NORMAL

3.11.3 Trigger on Pulse Width < 100 nsec

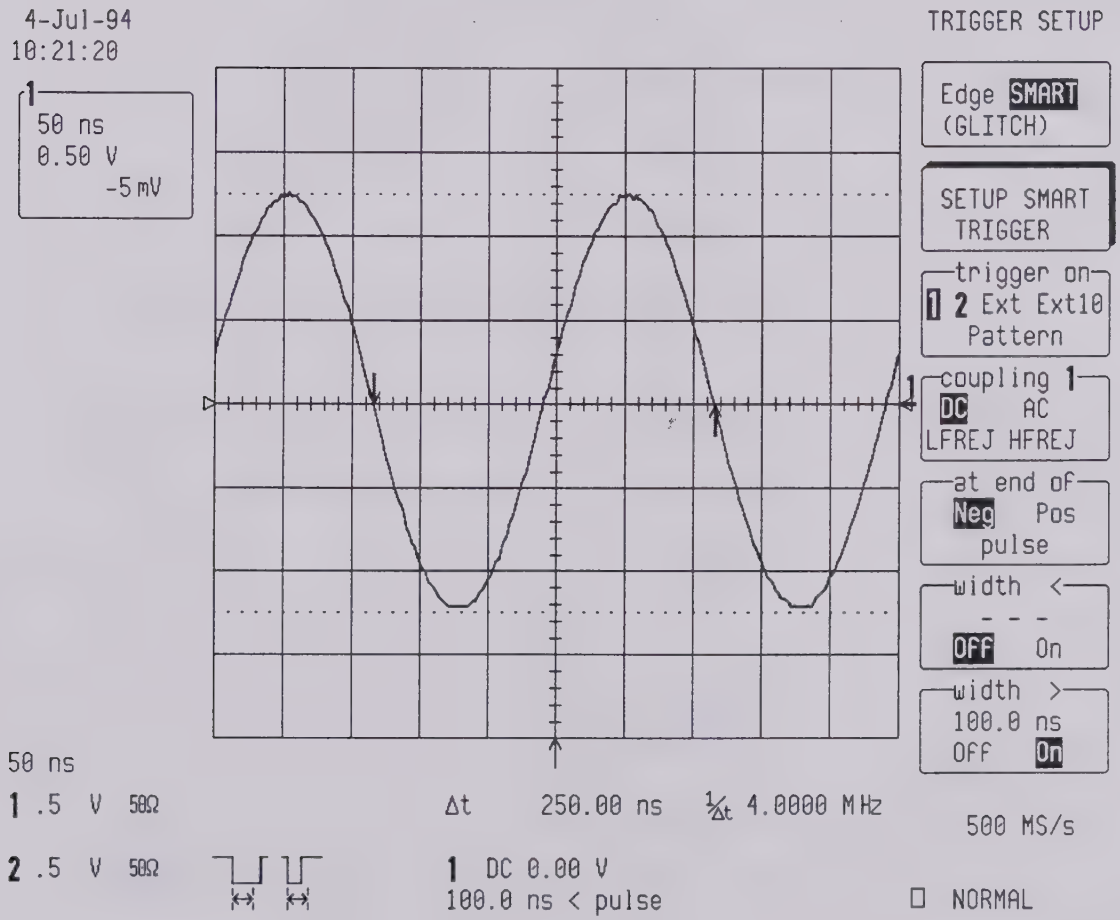
- Set the generator frequency to **10 MHz**
- Pulse width : **< 100 nsec**
- Timebase : **20 nsec/div.**
- Check that the scope triggers.



- Switch to Width : **> 100 nsec**
- Check that the scope **doesn't trigger** : slow trigger and no flashes in box next to normal.

3.11.4 Trigger on Pulse Width > 100 nsec

- Adjust the generator frequency to **4 MHz**
- Pulse width : **> 100 nsec**
- Set Timebase : **50 nsec/div.**
- Check that the scope triggers.



- Switch to Width : **< 100 nsec**
- Check that the scope **doesn't trigger** : slow trigger and no flashes in box next to normal.
- Repeat all the above tests for Channel 2, substituting Channel control and input connector, and check as above.

3.12 Time Base Accuracy

3.12.1 Description

An external sine wave generator of **1 MHz** with a frequency accuracy better than 1 ppm is used.

Specifications

500 MHz clock : accuracy : ≤ ± **0.001 % or ≤ ± 10 ppm**

3.12.2 500 MHz Clock Manual Verification Procedure

Setup a leveled sine wave generator.

- Frequency : **1 MHz**

- Connect the generator output to Channel 1

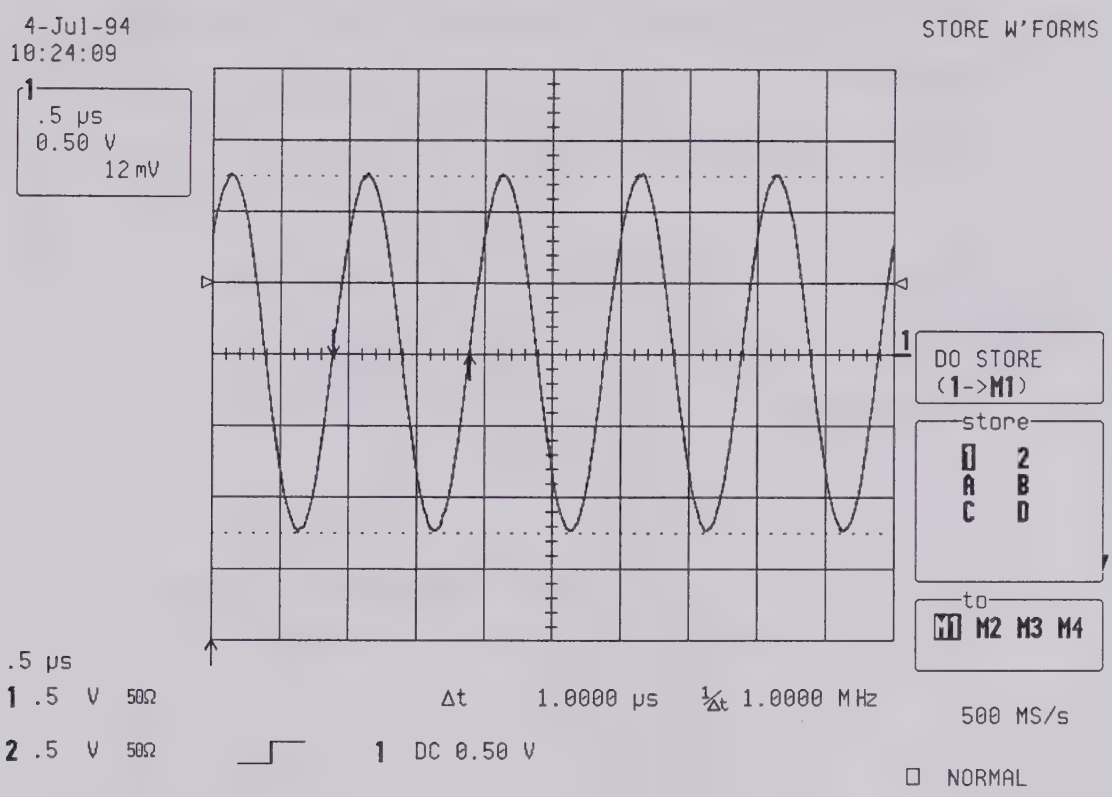
- Turn on trace : **Ch1**
- Display setup : **Standard, Persistence off, Dot join on, Single grid**
- Input Coupling : **DC 50 Ω**
- V/div. offset : **Normal**
- Probe atten : **X1**
- Input gain : **.5 V/div.**
- Trigger setup : **Edge**
- Trigger on : **1**
- Coupling 1 : **DC**
- Slope 1 : **Pos**
- Level 1 : **0.5 V**
- Mode : **Norm**
- Holdoff : **Off**
- Delay : **0 %**
- Timebase : **.5 µsec/div.**
- Channel use : **2**
- Record up to : **50 K**

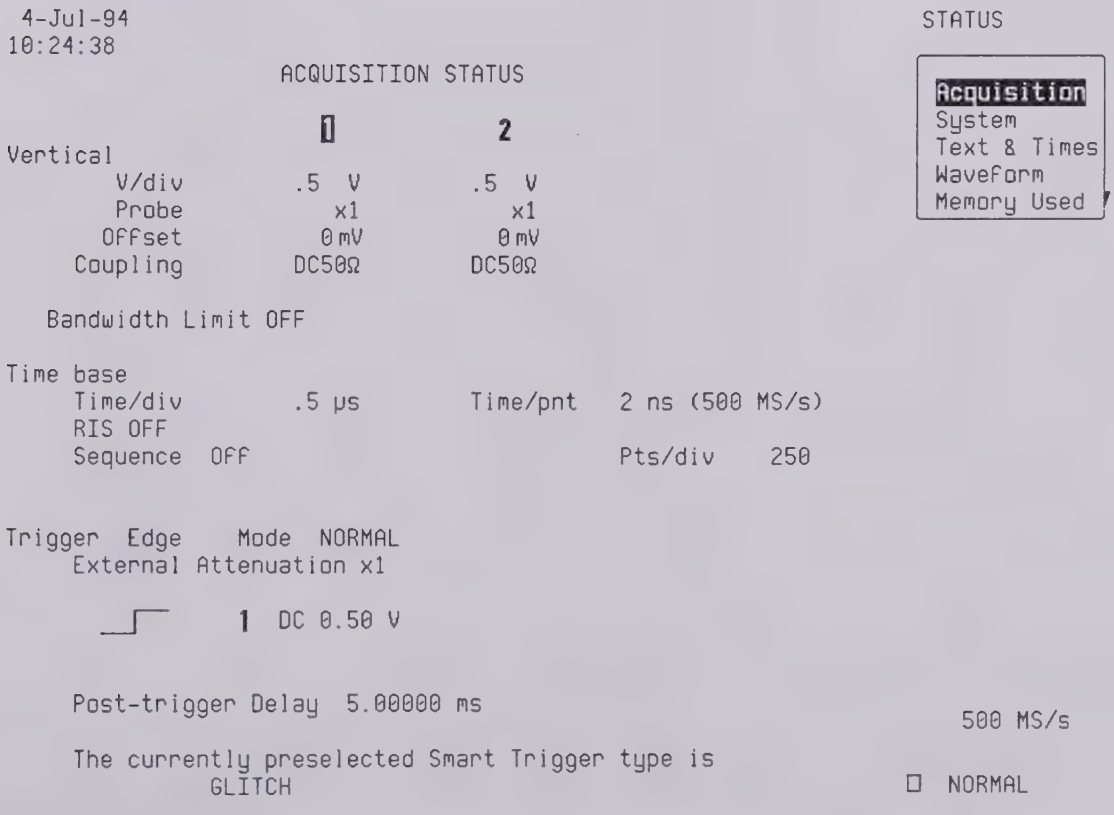
- Adjust the generator output amplitude and Ch1 offset to get a five divisions peak to peak amplitude sine wave.

- Store Channel 1 in Memory 1

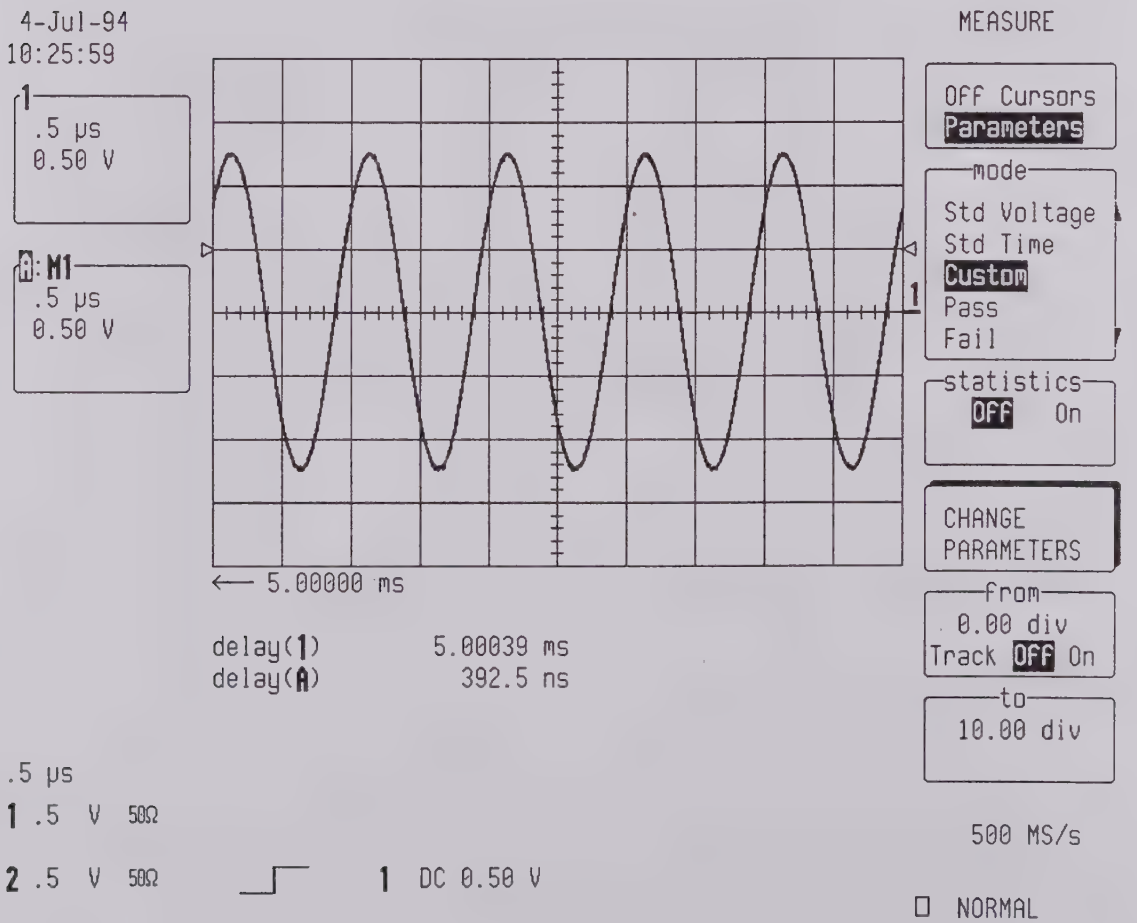
- Set Post-trigger delay to **5.00 msec**

This allows the accuracy of the time base clock to be checked **5000 periods** after the trigger point.


4-Jul-94
10:24:09
STORE W'FORMS
1
.5 µs
0.50 V
12 mV
1
DO STORE
(1->M1)
store
1 2
A B
C D
to
M1 M2 M3 M4
.5 µs
1 .5 V 50Ω
Δt 1.0000 µs 1/Δt 1.0000 MHz
500 MS/s
2 .5 V 50Ω
1 DC 0.50 V
NORMAL

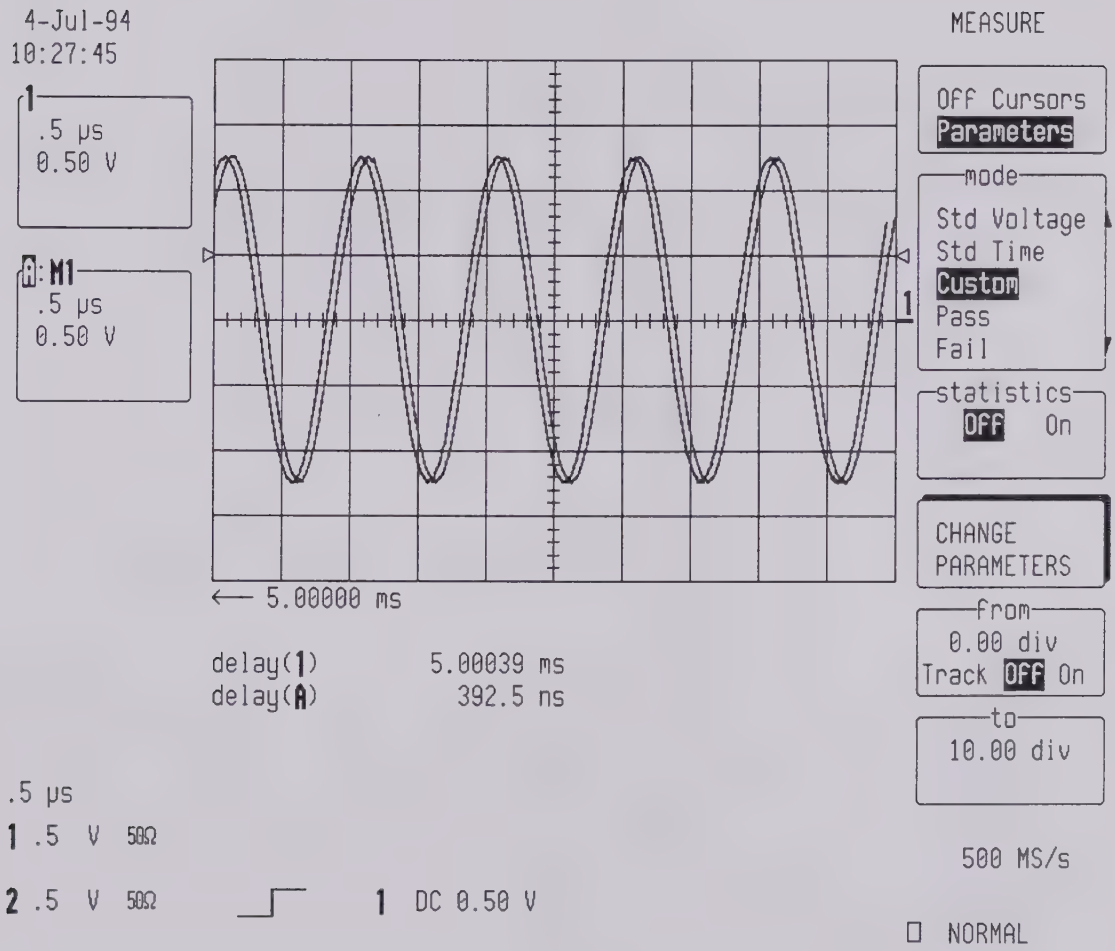

4-Jul-94
10:24:38
STATUS
ACQUISITION STATUS
Acquisition
System
Text & Times
Waveform
Memory Used
1 2
Vertical
V/div .5 V .5 V
Probe x1 x1
Offset 0 mV 0 mV
Coupling DC50Ω DC50Ω
Bandwidth Limit OFF
Time base
Time/div .5 µs Time/pnt 2 ns (500 MS/s)
RIS OFF
Sequence Off Pts/div 250
Trigger Edge Mode NORMAL
External Attenuation x1
1 DC 0.50 V
Post-trigger Delay 5.00000 ms
The currently preselected Smart Trigger type is
GLITCH
500 MS/s
NORMAL

- Recall Memory **1 to A**
- Turn on trace **A**
- Check that the displayed Channel 1 trace is **aligned** with the sine wave from memory 1.
- Press : **Cursors/Measure**
- Measure : **Parameters**
- Mode : **Custom**
- Statistics : **Off**
- Change parameters
- On line 1 : **Delay of 1**
- On line 2 : **Delay of A**
- Check that (**delay(A) - delay(1) - 5 msec**) ≤ ± **0.00005** msec corresponding to **10ppm.**



A difference of ± **0.05 µsec** corresponds to ± **10 ppm**.

See screen dump below :



3.13 Rise time (10%-90%)

Specifications

DC 50 Ω, 100 mV/div., : < .8 ns
DC 1 MΩ, 100 mV/div., : < 1.5 ns

Procedure

- Apply the fast pulse generator LeCroy 4969 (< 500 psec) or equivalent, to Channel 1
- Set the DSO as follows :

- Display setup : **Standard, Persistence off, Dot join on, Single grid**
- Input Coupling : **DC 50 Ω**
- V/div. offset : **Normal**
- Global BWL : **Off**
- Probe atten : **X1**
- Input offset : **- 250 mV**
- Input gain : **100 mV/div.**
- Trigger setup : **Edge**
- Trigger on : **1**
- Trigger level : **DC 250 mV**
- Coupling 1 : **DC**
- Slope 1 : **Pos**
- Mode : **Normal**
- Holdoff : **Off**
- Timebase : **2 nsec/div.**
- Channel use : **2**
- Record up to : **50 K**
- Delay : **30 % Pre-Trigger**
- Cursors/Measure : **Parameters**
- Mode : **Custom**
- Statistics : **On**
- Change Parameters :
- On line 1 : **Rise(1)**

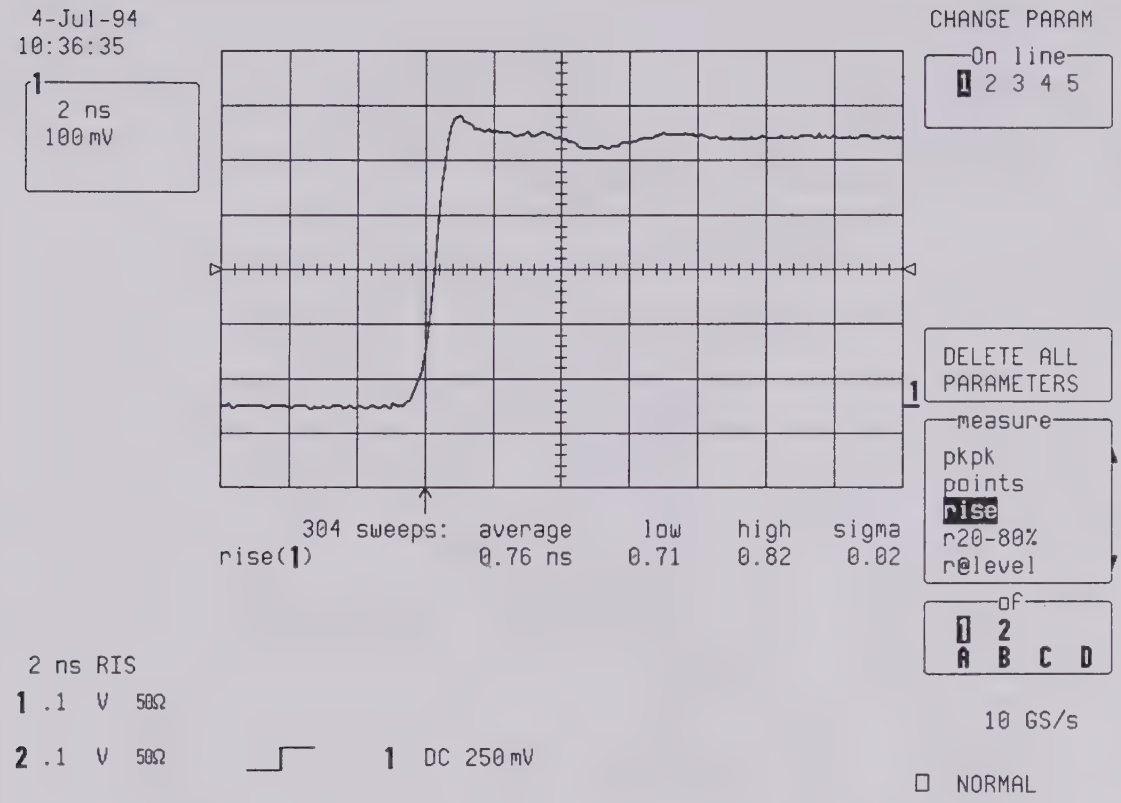
- After at least 100 sweeps, check that the Average rise time is < **.9 ns** (measured in scope and not corrected for the effect of the step generator).

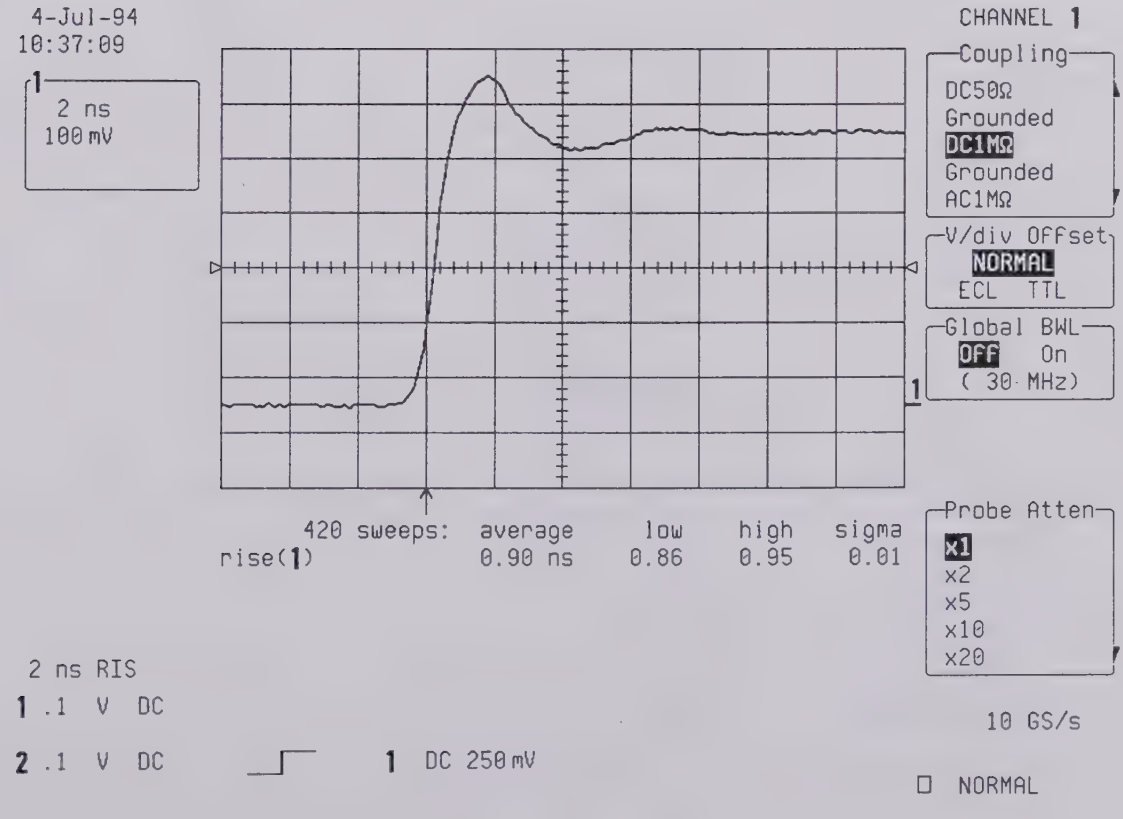
- Set Input Coupling : **DC 1M Ω**

- Terminate the output of the 4969 pulser with a **50Ω** feed through and connect it to Ch1

- After at least 100 sweeps, check that the Average rise time is < **1.6 ns** (measured in scope and not corrected for the effect of the step generator).

- Repeat the above tests for Channel 2, substituting Channel control and input connector, and check as above.


4-Jul-94
10:36:35
1
2 ns
100 mV
CHANGE PARAM
On line
1 2 3 4 5
DELETE ALL
PARAMETERS
measure
pkpk
points
rise
r20-80%
r@level
of
1 2
A B C D
304 sweeps: average low high sigma
rise(1) 0.76 ns 0.71 0.82 0.02
2 ns RIS
1 .1 V 50Ω
2 .1 V 50Ω
1 DC 250 mV
10 GS/s
NORMAL


4-Jul-94
10:37:09
1
2 ns
100 mV
CHANNEL 1
Coupling
DC50Ω
Grounded
DC1MΩ
Grounded
AC1MΩ
V/div Offset
NORMAL
ECL TTL
Global BWL
OFF On
(30 MHz)
Probe Atten
x1
x2
x5
x10
x20
420 sweeps: average low high sigma
rise(1) 0.90 ns 0.86 0.95 0.01
2 ns RIS
1 .1 V DC
2 .1 V DC
1 DC 250 mV
10 GS/s
NORMAL

3.14 Probe Calibrator Verification

Specifications

Amplitude : 50 mV to 500 mV ± **2 %** into 50Ω
: 50 mV to 1 V ± **2 %** into 1 MΩ

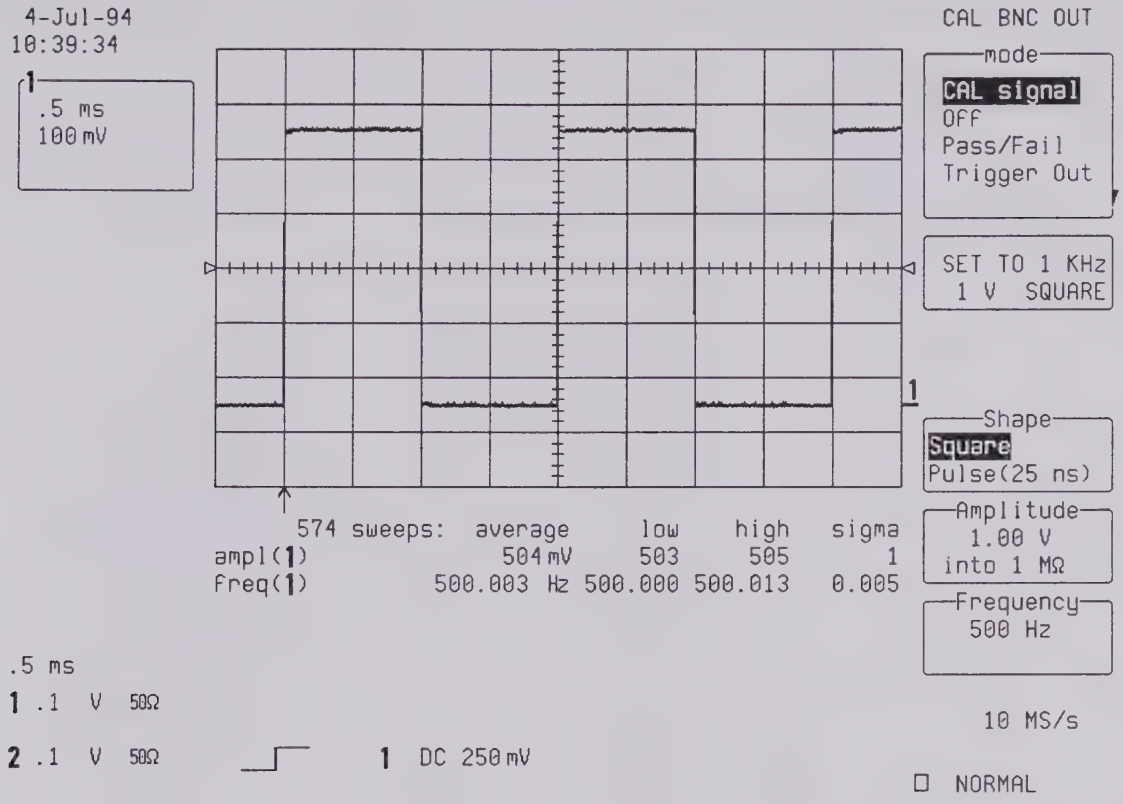
Frequency : 500 Hz to 2 MHz ± 1 ‰

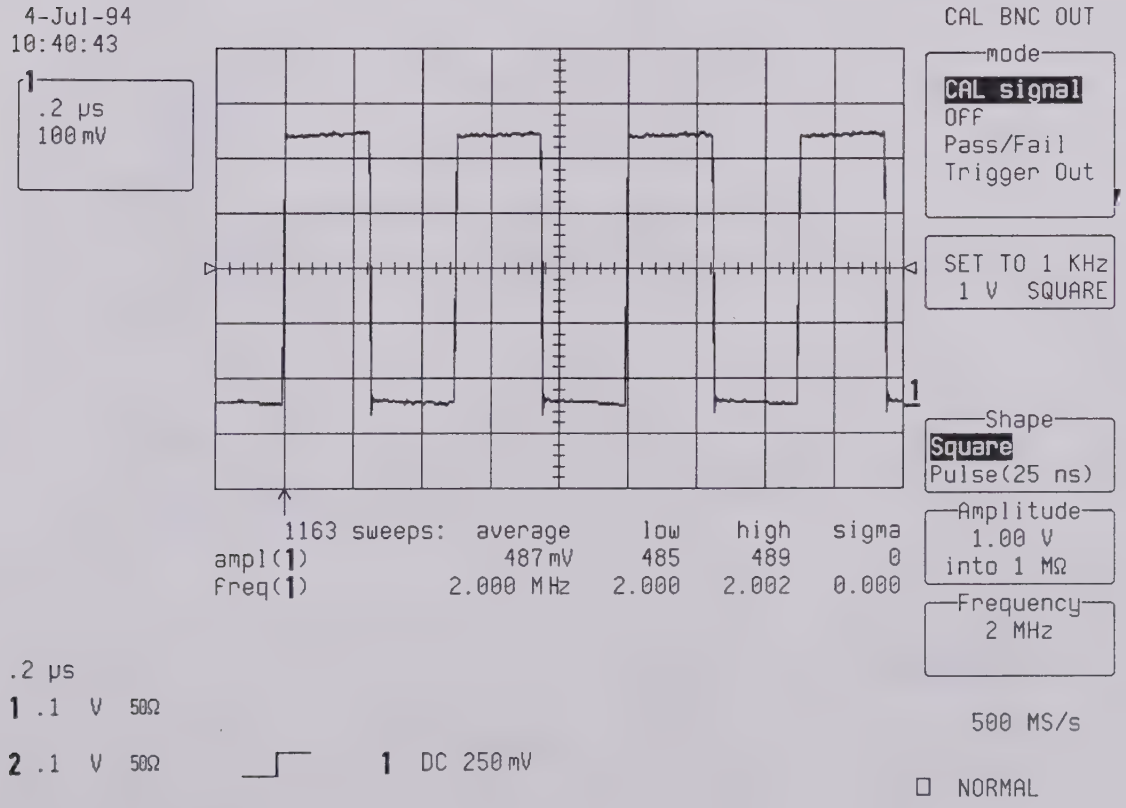
Probe Calibrator Verification Procedure

- Connect the Probe Calibrator output to Channel 1, using a 5 nsec BNC cable
- Select : **Utilities**
- Press : **Cal BNC Setup**
- Mode : **Cal signal**
- Set Frequency : **500 Hz**
- Amplitude : **1 V (500 mV into 50 Ω)**
- Turn on trace : **Ch1**
- Display setup : **Standard, Persistence off, Dot join on, Single grid**
- Input Coupling : **DC 50 Ω**
- V/div. offset : **Normal**
- Probe atten : **X1**
- Input offset : **- 250 mV**
- Input gain : **100 mV/div.**
- Trigger setup : **Edge**
- Trigger on : **1**
- Trigger level : **DC 250 mV**
- Coupling 1 : **DC**
- Slope 1 : **Pos**
- Mode : **Normal**
- Holdoff : **Off**
- Timebase : **.5 msec/div.**
- Delay : **10 % Pre-Trigger**
- Cursors/Measure : **Parameters**
- Mode : **Custom**
- Change parameters :
- On line 1 : **Measure ampl of 1**
- On line 2 : **Measure freq of 1**

- Check parameters readout : freq (1) = **500 Hz** ± 1 ‰ , and ampl (1) = **500 mV ± 6 %** (± **2 %** plus ± 4 % due to the non linearity of the scope)
- Set Cal frequency : **2 MHz**
- Timebase : **.2 µs**
- Check that freq (1) is **2 MHz** ± 1 ‰
- Repeat test for amplitude of **0.05 V** (25 mV into 50 Ω)
- Set Cal amplitude : **50 mV** (25 mV into 50 Ω)
- DSO Input gain : **5 mV/div.**

- Check parameters readout ampl (1) = **25 mV ± 6 %**

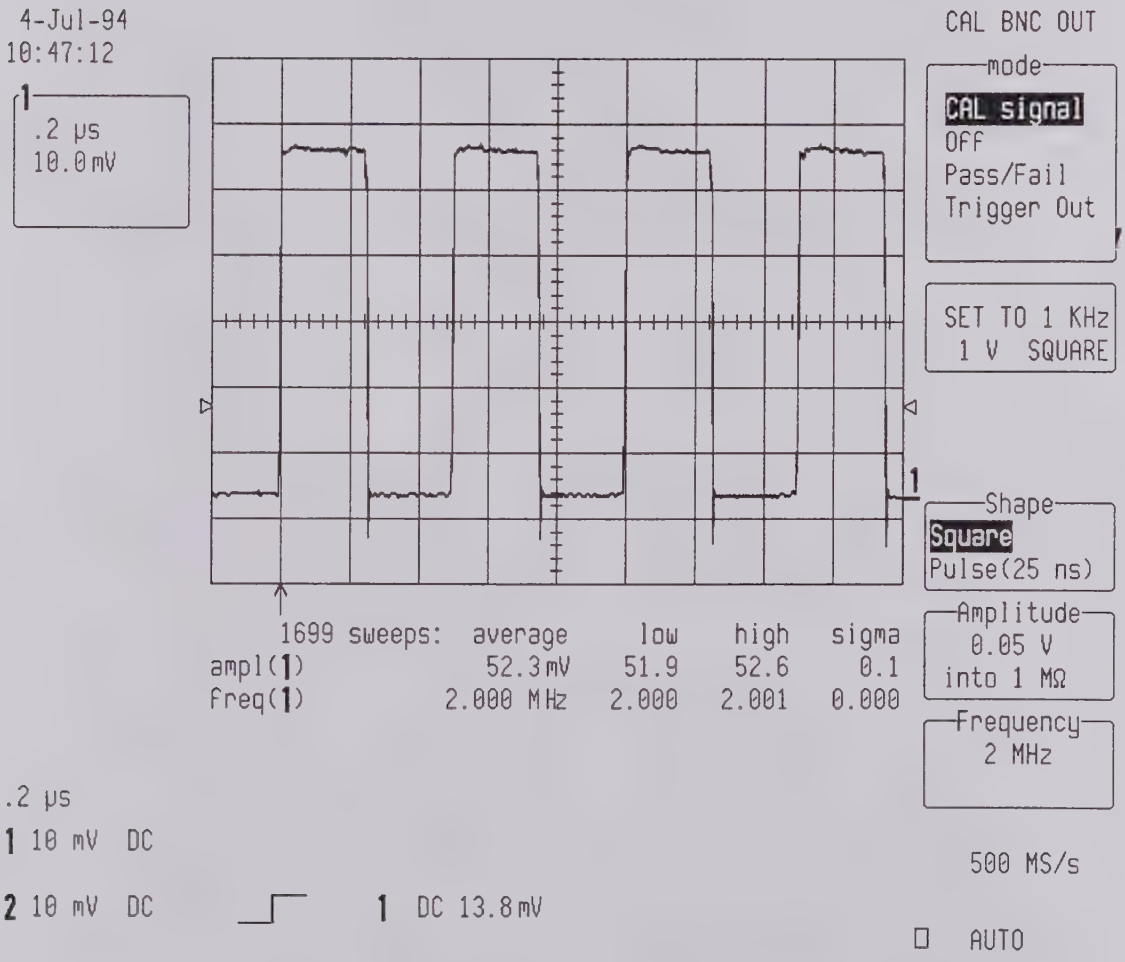

4-Jul-94
10:39:34
1
.5 ms
100 mV
CAL BNC OUT
mode
CAL signal
OFF
Pass/Fail
Trigger Out
SET TO 1 KHz
1 V SQUARE
Shape
Square
Pulse(25 ns)
Amplitude
1.00 V
into 1 MΩ
Frequency
500 Hz
574 sweeps: average low high sigma
ampl(1) 504 mV 503 505 1
freq(1) 500.003 Hz 500.000 500.013 0.005
.5 ms
1 .1 V 50Ω
2 .1 V 50Ω
1 DC 250 mV
10 MS/s
NORMAL


4-Jul-94
10:40:43
1
.2 µs
100 mV
CAL BNC OUT
mode
CAL signal
OFF
Pass/Fail
Trigger Out
SET TO 1 KHz
1 V SQUARE
Shape
Square
Pulse(25 ns)
Amplitude
1.00 V
into 1 MΩ
Frequency
2 MHz
1163 sweeps: average low high sigma
ampl(1) 487 mV 485 489 0
freq(1) 2.000 MHz 2.000 2.002 0.000
.2 µs
1 .1 V 50Ω
2 .1 V 50Ω
1 DC 250 mV
500 MS/s
NORMAL

- Repeat the tests for the amplitude of 0.05 V and 1 V into 1 MΩ

- Cal amplitude : **50 mV**
- Set Input Coupling : **DC 1M Ω**
- DSO Input gain : **10 mV/div.**

- Check parameters readout ampl (1) = **50 mV ± 6 %**



- Set Cal amplitude : **1 V**
- DSO Input gain : **200 mV/div.**

- Check parameters readout ampl (1) = **1 V ± 6 %**

3.15 Overload

Specifications

1 Watt into 50 Ω : Overload < 17 seconds

Procedure

- Set the DSO as follows :

- Display setup : **Standard, Persistence off, Dot join on, Single grid**
- Input Coupling : **DC 50 Ω**
- V/div. offset : **Normal**
- Global BWL : **Off**
- Probe atten : **X1**
- Input offset : **- 3.5 V**
- Input gain : **1 V/div.**
- Trigger setup : **Edge**
- Trigger on : **1**
- Trigger level : **DC - 0.04 V**
- Delay : **zero**
- Coupling 1 : **DC**
- Slope 1 : **Pos**
- Mode : **Auto**
- Holdoff : **Off**
- Timebase : **2 sec/div.**
- Channel Use : **2**
- Record up to : **1000 samples**

- From Tektronix power supply PS5004, apply **7.07 V** (1 Watt) to Channel 1.

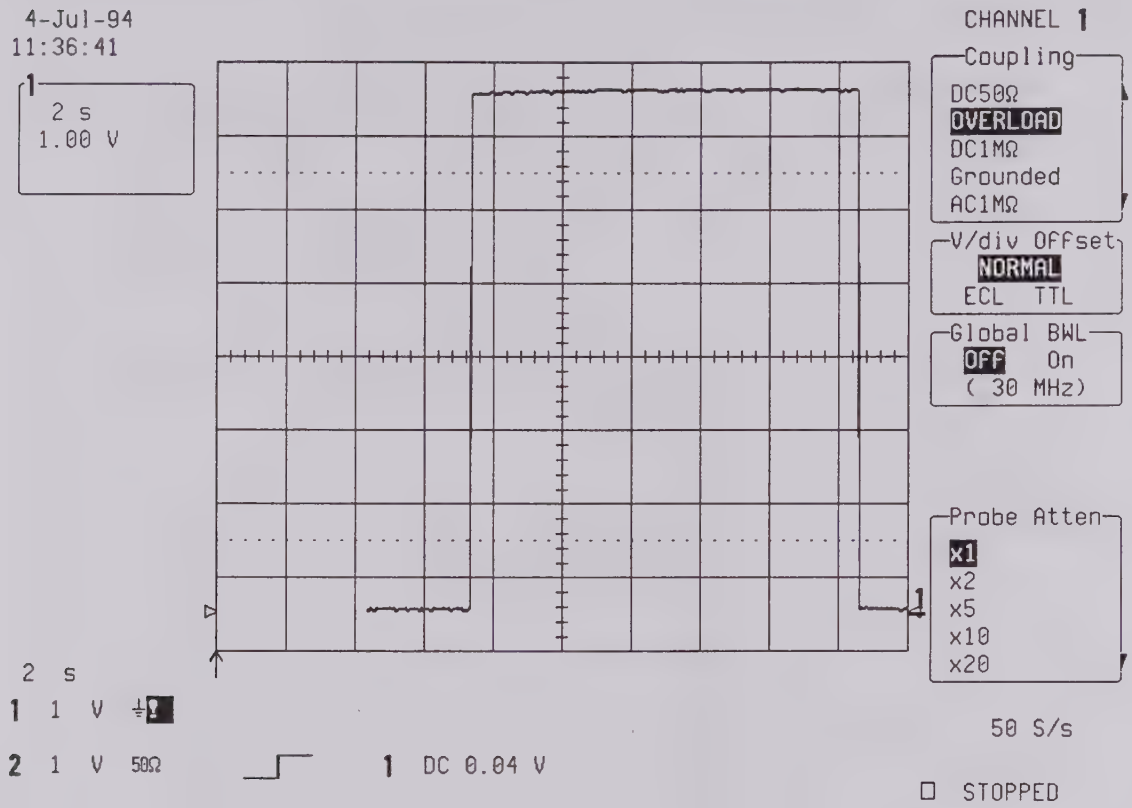
- Check that the overload trips, within **17** seconds.

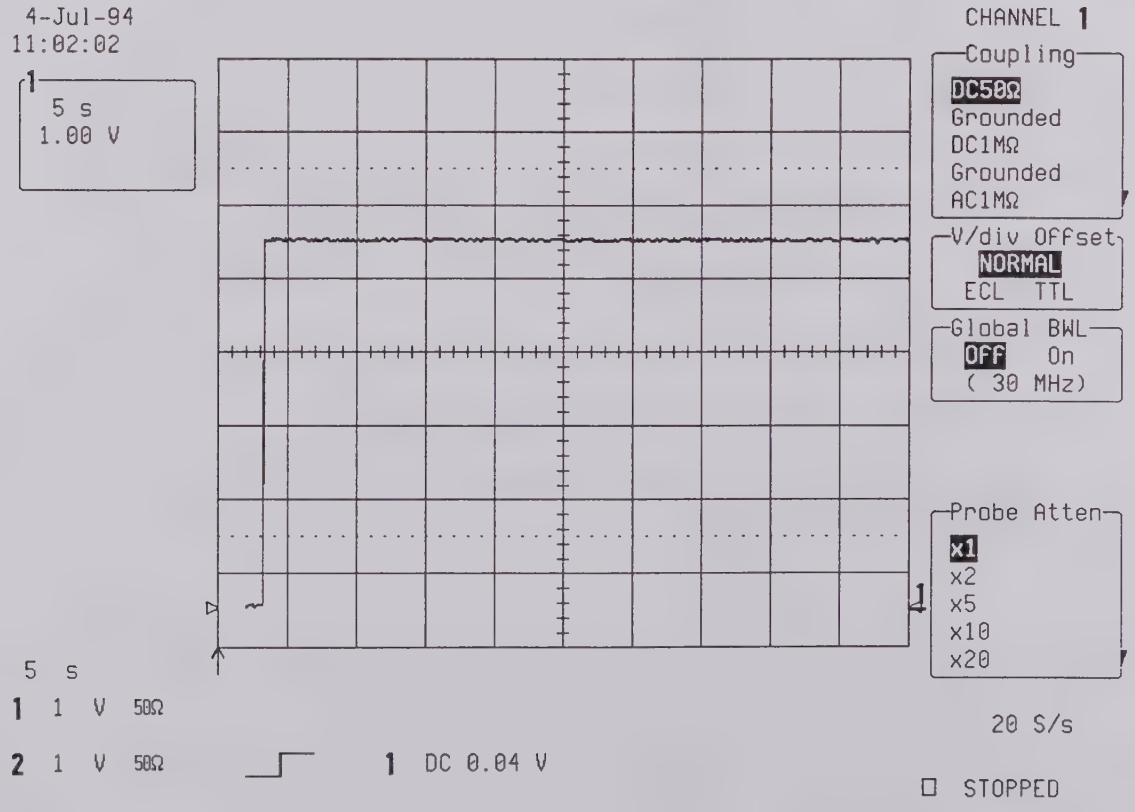
- Set Timebase : **5 sec/div.**

- From Tektronix power supply PS5004, apply **5 V** (.5 Watt) to Channel 1

- Check that the overload doesn't trip for at least **30** seconds.

- Repeat the above tests for Channel 2, substituting Channel control and input connector, and check as above.


4-Jul-94
11:36:41
1
2 s
1.00 V
CHANNEL 1
Coupling
DC50Ω
OVERLOAD
DC1MΩ
Grounded
AC1MΩ
V/div Offset
NORMAL
ECL TTL
Global BWL
OFF On
(30 MHz)
Probe Atten
x1
x2
x5
x10
x20
2 s
1 1 V
2 1 V 50Ω
1 DC 0.04 V
50 S/s
STOPPED


4-Jul-94
11:02:02
1
5 s
1.00 V
CHANNEL 1
Coupling
DC50Ω
Grounded
DC1MΩ
Grounded
AC1MΩ
V/div Offset
NORMAL
ECL TTL
Global BWL
OFF On
(30 MHz)
Probe Atten
x1
x2
x5
x10
x20
5 s
1 1 V 50Ω
2 1 V 50Ω
1 DC 0.04 V
20 S/s
STOPPED

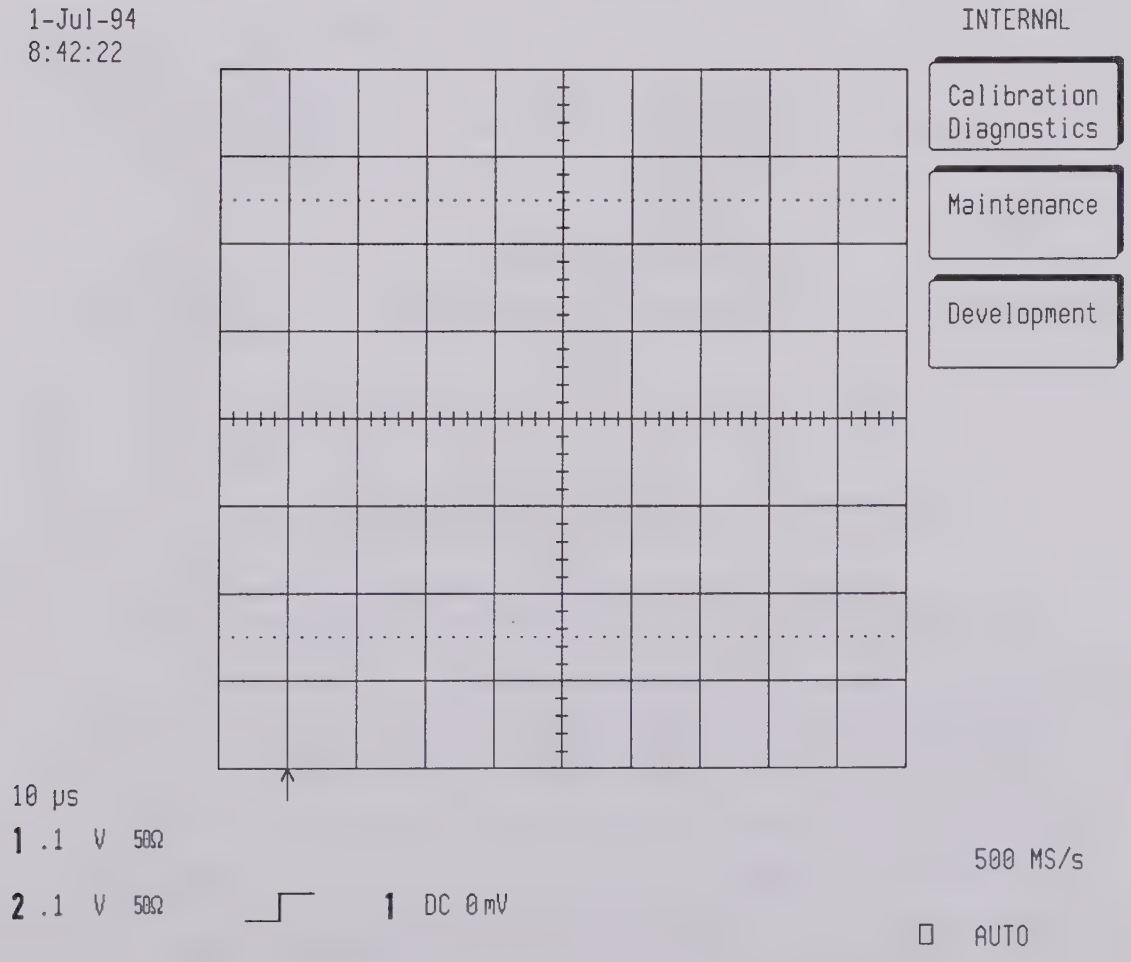
SECTION 4 INTERNAL CALIBRATION and DIAGNOSTICS

4.1 Introduction

- The 9350/M/L internal calibration use routines to confirm basic functionality, no test equipment is required to do these test procedures. The **diagnostics menu** is entered by simultaneously depressing the **third** and **fourth** menu push buttons on the right hand side of the CRT and then by depressing the **fifth**.

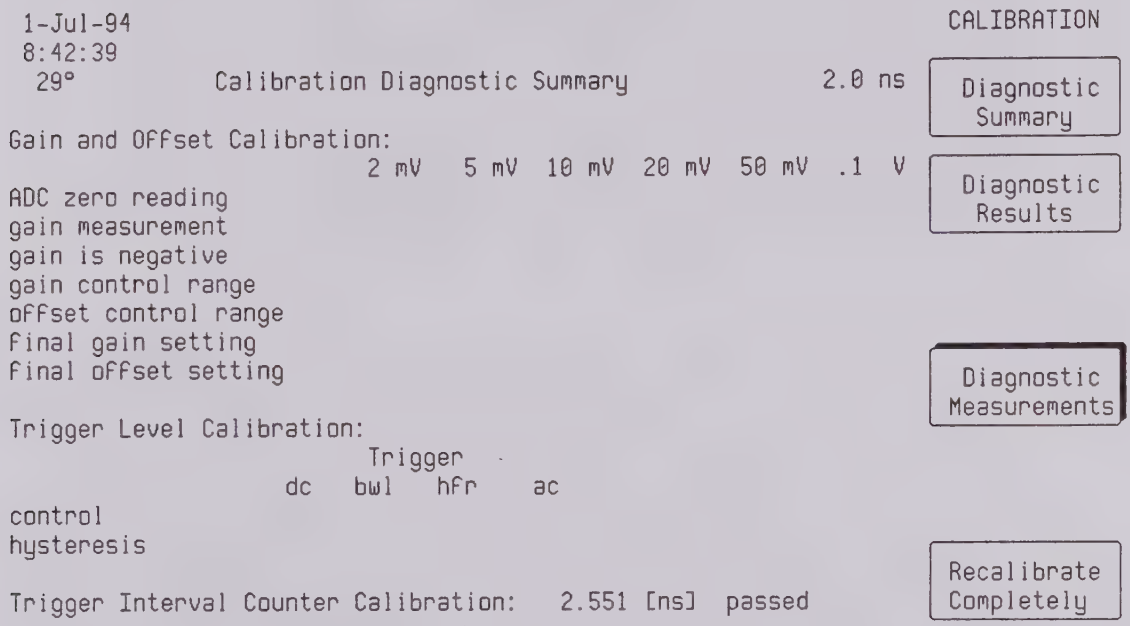
- To quickly check the performance of the digital storage oscilloscope, select the **calibration diagnostics**.

- Press the **recalibrate completely** button to do a full recalibration of the front end. It is advisable to perform this type of check when the scope is in a stable condition.



4.2 Diagnostic Summary

- Press **diagnostic summary**.
- This is a handy tool to perform a quick but comprehensive **internal performance** check, without touching the acquisition settings. The failures are indicated by channel identifiers.
- If no problem is detected, the fields are left **blank**.



Failures are indicated by channel identifiers. Fields are left blank if no problem detected or a failure occurred previously.

□

- The **gain** and **offset** calibration results displayed for Channel 1 and Channel 2, are independent of the following conditions:

- Time base
- 50 Ω or 1 MΩ input impedance
- BWL on or off
- Variable gain
- Offset
- Trigger mode and coupling

- The internal calibration is checked at **DC 1 MΩ**, and for the **six gain** settings : 2 mV, 5 mV, 10 mV, 20 mV, 50 mV, .1 V/div.

4.2.1 Gain and Offset Calibration Description

- ADC zero reading : Failed to get 0 reading from ADC for some choice of Vgain, and Cal signal, while varying the Offset
- Gain measurement : Failed to measure Gain, the gain was not what was expected.
- Gain is negative : Measured a negative Gain or broken channel.
- Gain control range : The range of the variable Gain is checked.
- Offset control range : The range of the variable Offset is checked.
- Final gain setting : An error is detected if the variable Gain and fix Gain adjustment do not converge to the desired Gain.
- Final offset setting : An error is detected if the 3 Offset calibration points do not lie on a straight line.

4.2.2 Trigger Level Calibration

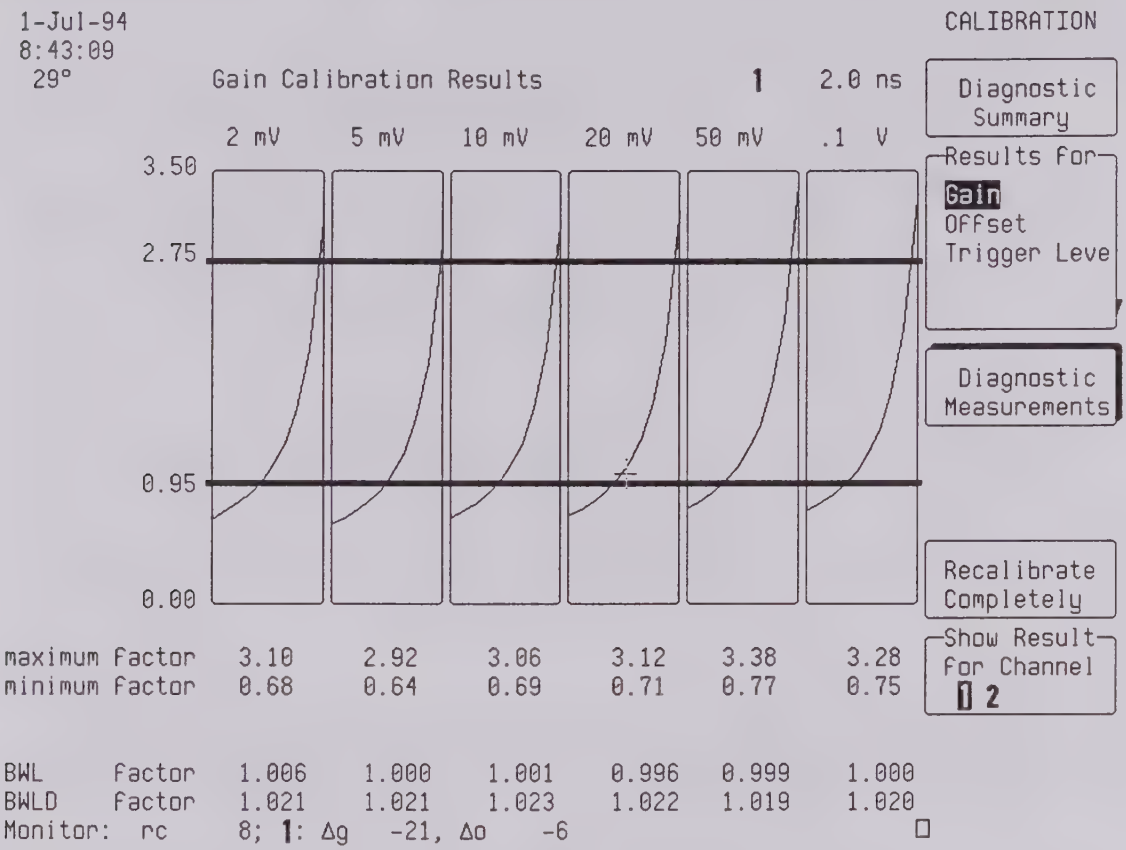
- The control of the trigger hysteresis is done in the trigger mode DC, BWL on, HFr, and AC. If an error has occurred 1, 2 or E is displayed corresponding to Channel 1, Channel 2 or External.
- Control : Failed if no transition of discriminator observed when stepping the Threshold level.
- Hysteresis : Failed to get correct Hysteresis.

4.3 Diagnostic Results

4.3.1 Gain Curves

- Press **diagnostic results**
- Select results for **gain**
- Press **recalibrate completely**
- Select show results for **Channel 1**

- Variable gain range, checked by software must be better than 0.95 to at least 2.75. With regards to the illustration, the lower portion of the curve must extend below **0.95** limit, and the upper portion above the **2.75** limit.
- If this is not true the Gain control range summary shows a violation for Channel 1.
- The maximum and minimum gain factors are displayed.



- Repeat the test for Channel 2.

4.3.2 Offset Curves

- Select results for **Offset**, and show result for **Channel 1**

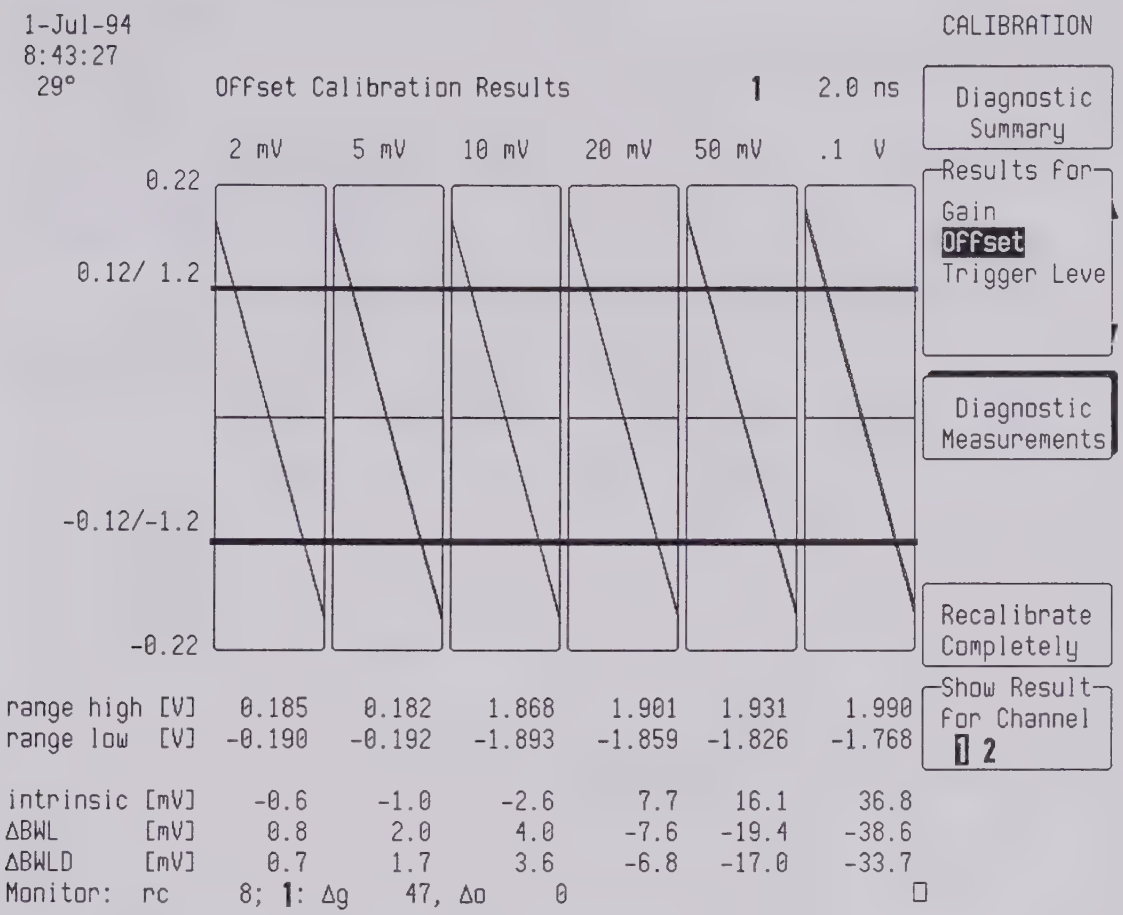
  X = offset DAC range
  Y = offset

- The curves should be above the positive limits **+ 0.12 V / + 1.2 V** and below the negative limits **- 0.12 V / - 1.2 V**.

- For the sensitivities 2 mV, 5 mV/div. a 1/10 attenuator is used, the limits are **± 0.12 V**.
- For the sensitivities 10 mV, 20 mV, 50 mV, 0.1 V/div. the limits are **± 1.2 V**.
- The maximum and minimum offset is ± 1.2 V. The calibration verifies that the DAC can reach this value.

- The intrinsic value represents the offset in mV that should be applied to get zero offset to the ADC.

  NB : ΔBWL is the difference between BWL on and BWL off.



- Repeat the test for Channel 2.

4.3.3 Trigger Level Calibration

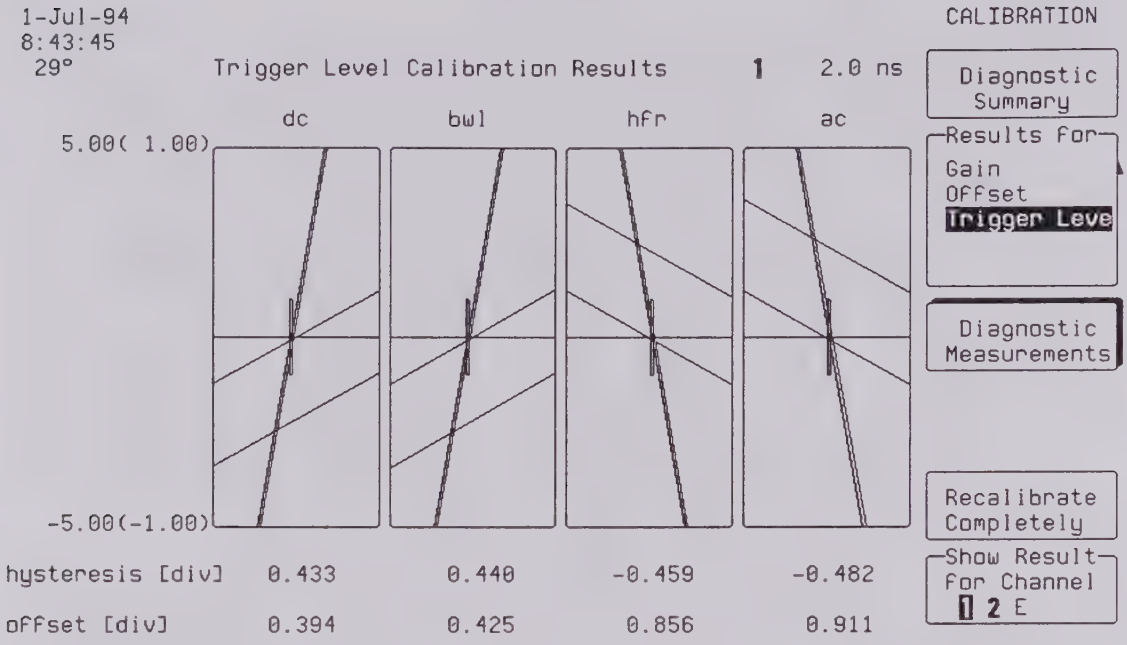
- Select results for **trigger level**

- For Channel 1 and Channel 2 the hysteresis value for trigger DC, BWL, HFR, AC is given in **divisions**. The trigger range is ± 5 div. for the steep curve. The boxed region is zoomed to give the two lines with a vertical scale of ± 1 div. The external trigger hysteresis is given in Volt. The offset of the positive curve relating trigger threshold to DAC setting is given.

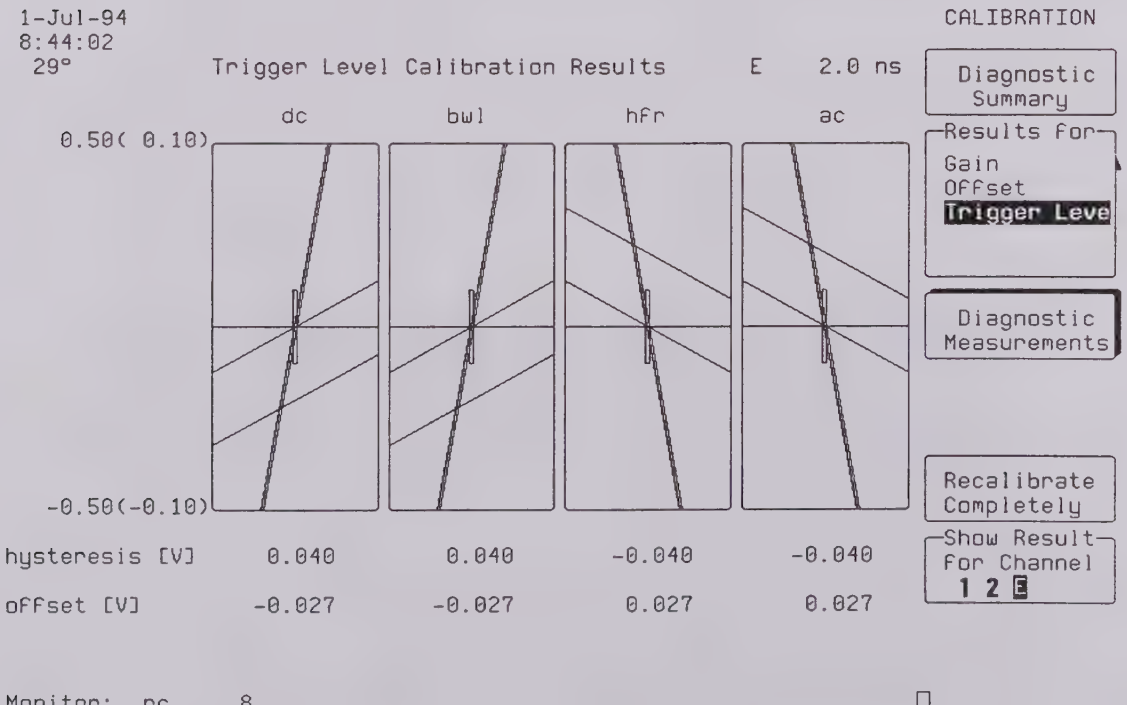
- Press **recalibrate completely**
- Select show result for **Channel 1**

- The **DC** hysteresis in div. should be **± 0.4 div. ± 0.1 div.**

- Repeat the test for Channel 2.



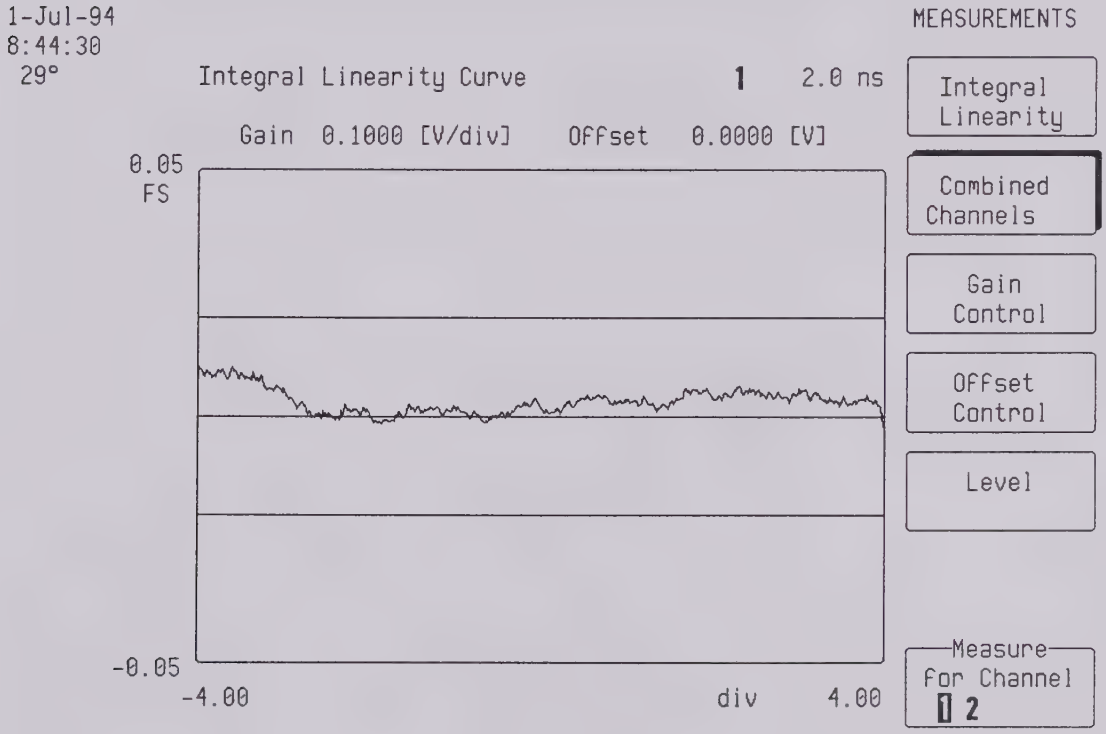
- Select show result for **External trigger**
- The hysteresis in Volt should be **± 0.04 V ± 0.02**



4.3.4 Integral Linearity

- Press **diagnostic measurements**
- Select **integral linearity**
- Measure for **Channel 1**

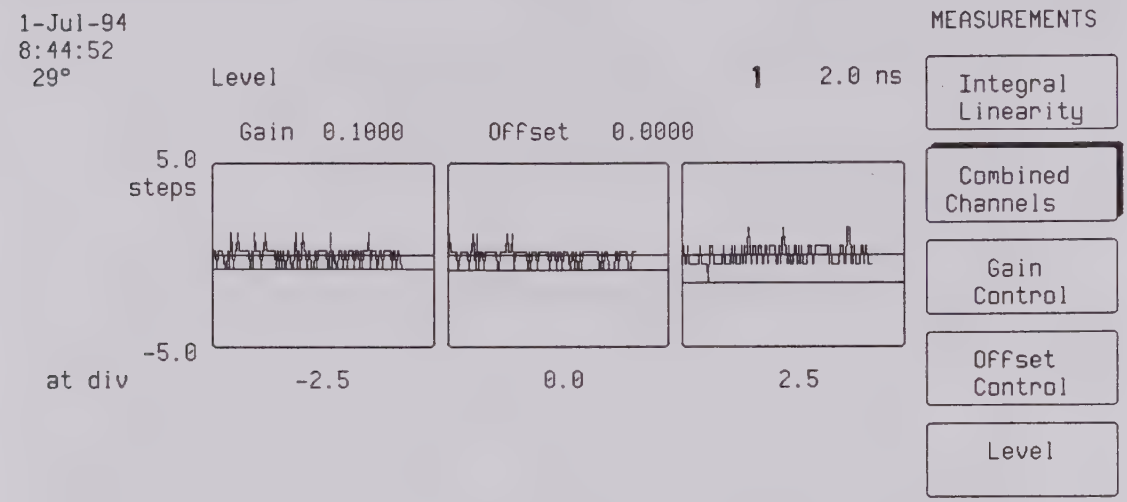
- The integral linearity curve should be within the ± 0.05 * FS bars, for offset = 0.0 V.



- Repeat the test for Channel 2.

- Press **level**
- Measure for **Channel 1**
- The three plots show raw ADC data displayed around their mean value for 3 different CAL levels.
- The data should be **narrow** and random.

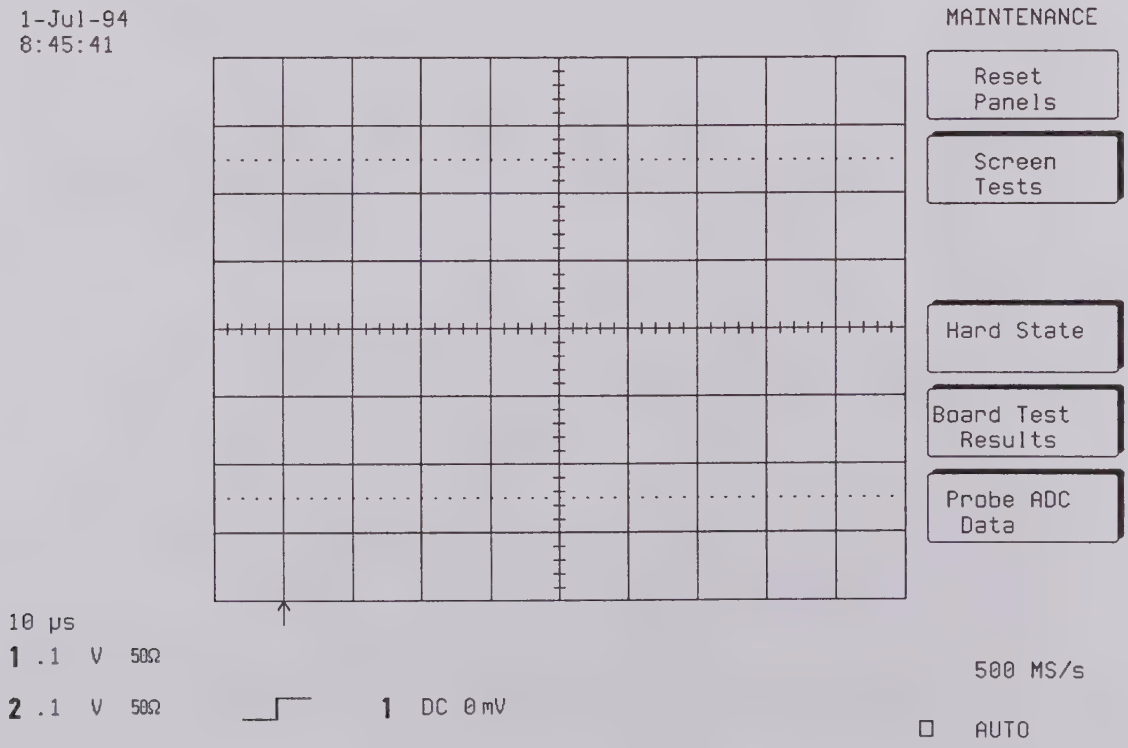
- The theoretical level is shown by the second horizontal line which should be near (< 4 steps) to the measured value for Offset = 0.



- Repeat the test for Channel 2.

4.4 Board Test Results

- From the Internal menu press **Maintenance**
- Select **Board Test Results**



- This menu displays the board calibration measured at the factory, the calibration values are loaded in the I2C Prom.

- The header block indicates the following information :
- The test version : i.e. 147
- The revision of the printed circuit board : i.e. Rev C
- The engineering change order level : i.e. ECO 1005
- The work order number : i.e. WO 9421-0050
- The tested date : i.e. tested 1994-06-21 it should be : ≥ 1993-xx-xx.
- If the date says 1990-04-01 it is a sign that the I2C prom on the -3 board can not be read correctly.

- The gain, offset, level, timing, delay values shown in this menu are used to perform the internal calibration of the scope. If more extensive information of those parameters is required, see the 9350/M/L Service Manual.

```
 1-Jul-94                                                    Board Test
 8:45:58

Header:    block lengths 20 32 14 Test version 147  2 chans
       Rev: C, ECO 1005, WO 9421-0050, Tested: 1994-06-21  8:38

CAL levels:  (E665,-2000mV)  (8008,    0mV)  (19AB, 2000mV)
EXT trigger: pos.  (AB60, -410mV)  (56A8,  416mV)
             neg.  (A740, -410mV)  (5280,  416mV)
EXT/10 attenuator:    10.055
Delay correction:    20.00 ns

ADC control:  clock period    gain DAC  offset DAC
     2.00 ns  68  9e      2.50 ns  7e  7e      5.00 ns  93  87
Inter channel delay:      0 ps

ADC control:  clock period    gain DAC  offset DAC
     2.00 ns  a2  87      2.50 ns  7e  80      5.00 ns  b1  7d
Inter channel delay:      0 ps
```

4.5 Probe Bus Verification

- From the Internal menu press **Maintenance**
- Select **probe ADC data**
- This menu displays the probe bus and probe ring status.
- With no probe connected to the input, check that the value in the first column is **251 ± 2** for Channel A, B, C, D, and Ext.

```
1-Jul-94                                                    Probe Data
8:46:43
              value    limits  interrupts
Channel A     252  253 [245,255]     0
Channel B     253  253 [245,255]     0
Channel C     252  252 [245,255]     0
Channel D     252  252 [245,255]     0
Channel EXT   252  252 [245,255]     0
Channel CAL   252  252 [  0,255]     0
Channel MON   125  125 [ 73, 79]     0
Channel T      96   93 [ 87, 99]    10    Temperature  29°C
```

- Connect a **AP020** LeCroy active probe to Channel 1 and check that:
- The probe is identified on physical **Channel C**
- The Channel C value indicates in the first column has changed to **21 ± 2**
- An **interrupt** has been detected on Channel C

```
1-Jul-94                                                    Probe Data
8:48:04
              value    limits  interrupts
Channel A     252  253 [245,255]     0
Channel B     253  253 [245,255]     0
Channel C      21   21 [  6, 26]     1    AP020
    01 08 00 41 50 30 32 30 04 06  93 25 00 07 11 06 41 20 00 00
    15 06 3d cc cc cd 21 0a 40 17  a0 3b 38 97 a0 92 22 0b c0 00
    00 00 40 00 00 00 01 24 07 01  46 42 01 00 34 06 00 10 00 42
    36 04 02 04 41 06 32 04 48 f5  00
Channel D     252  252 [245,255]     0
Channel EXT   252  252 [245,255]     0
Channel CAL   252  252 [  0,255]     0
Channel MON   125  125 [ 73, 79]     0
Channel T      96   93 [ 87, 99]    10    Temperature  29°C
```

- Connect a LeCroy passive probe with probe ring i.e. **PP002** to Channel 1 and check that :
- The probe **X10** is identified on physical Channel C
- The Channel C value indicates in the first column has changed to **195 ± 2**
- An **interrupt** has been detected on C

```
 1-Jul-94                                                    Probe Data
 8:48:41
              value    limits  interrupts
Channel A    252  253 [245,255]     0
Channel B    253  253 [245,255]     0
Channel C    195  193 [173,204]     3    x10
Channel D    252  252 [245,255]     0
Channel EXT  252  252 [245,255]     0
Channel CAL  252  252 [  0,255]     0
Channel MON  125  125 [ 73, 79]     0
Channel T     96   93 [ 87, 99]    10    Temperature  29°C
```

- Repeat the tests for Channel 2 and External Trigger.
- Check that the probe is identified on physical Channel D or Ext.

```
 1-Jul-94                                                    Probe Data
 8:48:59
              value    limits  interrupts
Channel A    252  253 [245,255]     0
Channel B    253  253 [245,255]     0
Channel C    252  249 [242,255]     4
Channel D    252  252 [245,255]     0
Channel EXT  194  193 [173,204]     1    x10
Channel CAL  252  252 [  0,255]     0
Channel MON  125  125 [ 73, 79]     0
Channel T     96   93 [ 87, 99]    10    Temperature  29°C
```

LeCroy